Editorial

AT last the TV corner has been turned, that corner which has eluded us for the past 20 years. At times it has been tantalisingly close, and at others it has receded into a wilderness of argument and cross purposes.

But with the granting of four commercial licences last month, two each in Sydney and Melbourne, it is safe to say that we have finally made the grade, and can now take a good, long, gaze at what is beyond it.

Firstly, no one can have any serious quarrel about the licence allocation, and few people were surprised to read the names of the successful applicants.

It is quite true that they represent big companies. But who else could successfully handle such a vast enterprise because it is vast? Those who are about to embark on TV activities will need every resource they can command to make a success of it, and it would have been almost criminal folly to have granted licences to anyone not able to meet the obligations which lie squarely on their shoulders.

Despite mutterings that a possible Labor Government would cancel commercial licences if they were granted, I do not think there is the slightest chance of this happening. Commercial TV is and always has been completely inevitable in Australia, if only because the free expression of private enterprise has always been inherent in our make-up. We heartily congratulate those who have been selected to turn the first sod, and wish them success after it.

It is likely that preparations for regular services will now go ahead quite quickly. Already a commencement date has been mentioned—within 18 months, and this is not impossible. It is likely, however, that all of that time will be needed in most cases, although test transmissions may take place well before it.

Australian set manufacturers have been extremely busy of late working out their production problems, and these will now be greatly intensified. The desire to recover initial costs as quickly as possible will be a high inducement to get things moving with the least delay.

No doubt we shall hear before long something of the plan of the ABC for national programs. One thing is certain, the next few months will be teeming with interest on the TV front.

John Moyle

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RADIO TELEVISION & HOBBIES

A NATIONAL MAGAZINE OF RADIO, TELEVISION, HOBBIES AND POPULAR SCIENCE

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Phone .. .. BO 333

OUR COVER PICTURE: Tom Tomlinson, a research engineer for an American Aviation Company, who is in a 65-degree-below-zero "Cold Box" in the Company's Aeronautical Laboratories. He gives an operating test to a new, simplified, pilot's ejection seat. Frosted dummy represents average pilot's weight. Seat is checked at wide range of temperature and climatic conditions to make sure it will operate at all altitudes in every part of the world.

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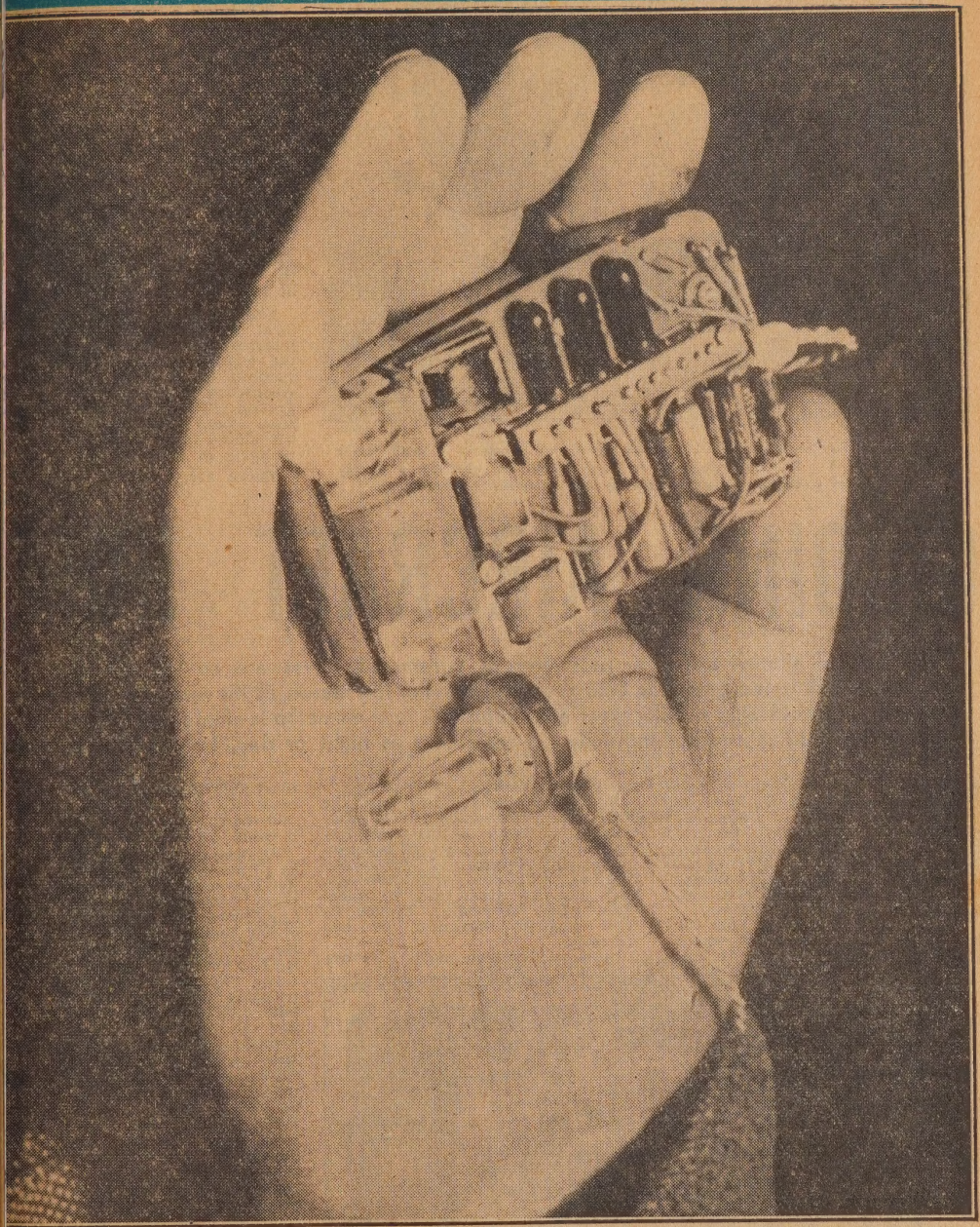
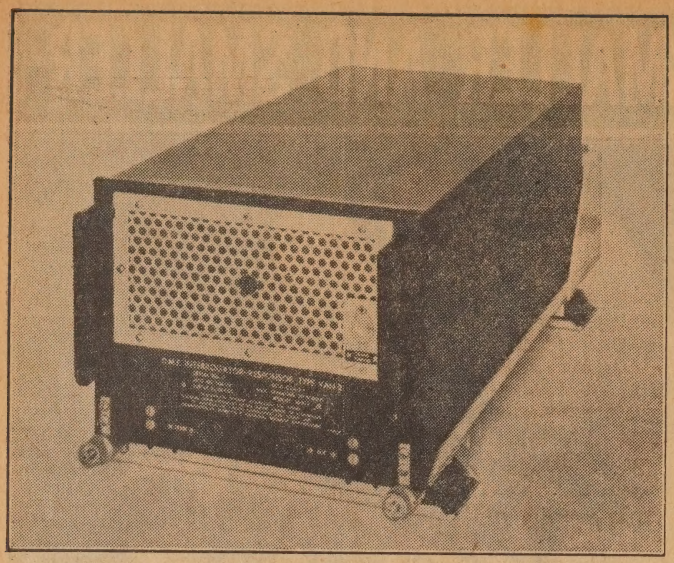


Radio receivers, hearing aids, electronic equipment, all are beginning to show the influence of the tiny transistor which is slowly replacing conventional radio valves for many uses. This baby set recently exhibited at a Paris Radio Exhibition has good range and has an ear-plug receiver to listen to programs. The three black-bodied transistors are clearly visible. The whole receiver is only a few inches long.



This is all the equipment the aircraft carries except the aerials — a small "black box" measuring 8 x 10 x 21 inches and weighing 36.5lb. The pilot has a display dial and a control panel to make up the complete installation.

called upon to guide the aircra accurately through the major pa of its journey, to indicate its heigh and finally to provide an electron path along which it can fly in final approach until the wheels a about to touch down on the tarma

The radio aid to be described he is intended to give instant visu indication to a pilot of his distan from a radio beacon on the groun and to allow him to identify th beacon. It is not intended to pr vide him with a course on which fly, this facility being in the care a different type of navigational ai The beacon will supply its distan information no matter in what dire tion the aircraft may approach

The equipment, which has be developed in Australia by t CSIRO, Amalgamated Wirele (Australasia) Ltd., and the Depar ment of Civil Aviation, is known the Distance Measuring Equipmer or DME in abbreviated reference.

The duties it is required to pe form are virtually standardised b international agreement througho the world, but unfortunately the fr quencies to be used are not. Th Australian preference for a ba around 200 Mc is not shared ove seas, where a band near 1000 Mc considered to be more suitable, pa ticularly in areas of dense traffic

There are, however, many tec

GUIDING AIRCRAFT HOMI

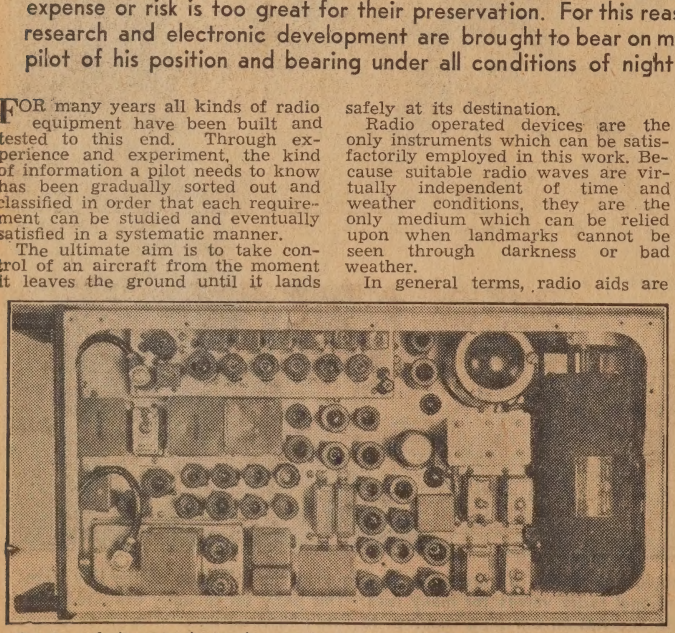
The safety of aircraft and their passengers is paramount. Lives are so valuable that no expense or risk is too great for their preservation. For this reason, all the resources of modern research and electronic development are brought to bear on methods of informing the aircraft pilot of his position and bearing under all conditions of night or day, fair weather or foul.

FOR many years all kinds of radio equipment have been built and tested to this end. Through experience and experiment, the kind of information a pilot needs to know has been gradually sorted out and classified in order that each requirement can be studied and eventually satisfied in a systematic manner.

The ultimate aim is to take control of an aircraft from the moment it leaves the ground until it lands safely at its destination.

Radio operated devices are the only instruments which can be satisfactorily employed in this work. Because suitable radio waves are virtually independent of time and weather conditions, they are the only medium which can be relied upon when landmarks cannot be seen through darkness or bad weather.

In general terms, radio aids are



The top of the unit shown above without the cover illustrates the compact unit construction. The receiver is at the top and the transmitter in the lower left corner. The generator power supply is at the right, with its voltage regulator.

nical difficulties about the use a construction of 1000 Mc equipmer and many delays loom ahead befo it could be universally accepted.

Australia, therefore, has decid to go ahead with the 200 Mc desi for use within its boundaries, a many aircraft have already be fitted with this equipment. With a few months it will be necessa for all commercial aircraft to car DME before they will be allowed carry out normal services. It probable that some aircraft comi here from overseas will also car it.

DME is a development from rad technique in that it relies on t transmission and reception of rad pulses of short duration from t aircraft to the ground and retur Because radio waves travel at a co stant speed, the time taken for t pulses to do this can be convert into units of distance, and the resu ing information displayed on a d calibrated to read directly nautical miles, the unit of distan used in flying.

But whereas true radar uses series of single pulses for this pu pose, and relies on their reflecti from objects to operate the equi ment, DME does not.

The pulses sent out by the speci transmitters in the aircraft are r

ed by suitably sited DME
ons, and used to trigger trans-
ers which radiate corresponding
es of much greater strength than
e obtained merely by reflection.

ne range and reliability of the
em is thus greatly increased, and
ddition, there are other advant-
to be gained by controlling
coding the reply pulses sent out
he aircraft from the ground.

ne contract for the ground
ons to be supplied to DCA is for
installations of which 50 have
delivered and about 35 either
alled or in the process. These
be located all over Australia to
ride continuous coverage over the
n air routes. Others will go to
os Island, Papua and New
nea, Norfolk Island, and prob-
other points as well.

bout 170 airborne equipments
be delivered, and about 50 of
se are already installed in air-
ft.

ERATING RANGE

he operating range of DME is
gely a function of the frequencies
d, which have largely a visual
erage to the horizon and slightly
ond. Height of the aircraft and
the ground aerials is therefore a
al point.

he beacon aerials are arranged to
iate their energy at a low angle
the ground, with little coverage
a vertical direction. This achieves
useful concentration of power to
points of the compass.

Ground reflections play an import-
point in determining the exact
gle at which the strongest signal
ll leave the ground in any one
ection, and no attempt is made
use maximum possible range in
rmal operations.

At typical operating heights be-
een capital cities, 100 miles is
cepted as a useful figure, but high-
ing aircraft with a more distant
rizon can make use of a 200 mile
nge at 15-20,000 ft. Jet aircraft at
-40,000ft might be able to work
far as 300 miles, and suitably
odified equipment will be avail-
le for such cases.

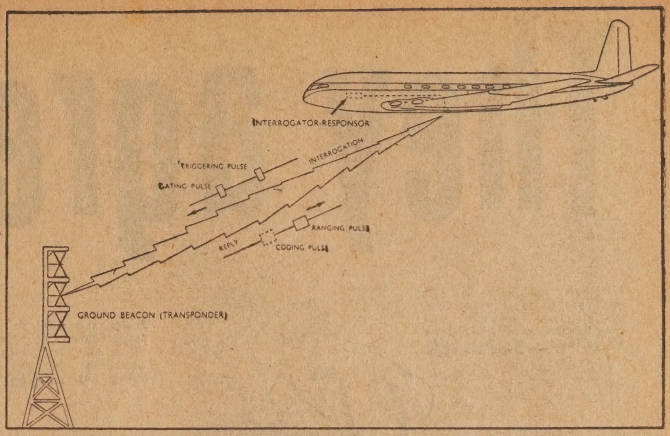
The beacon aerials have three
oad-banded cone-shaped half-
ave sections stacked one above the
her, and fed in suitable phase to
ve a main lobe approximately 10
grees from horizontal. They are
ually mounted on 75ft masts,
though this height may vary ac-
rding to local topography.

OUBLE PULSE

The system envisages numerous
rcraft flying along set courses with
eir transmitters "interrogating"
ound beacons, the positions of
hich are known to the aircraft
lot. If all the beacons were to
espond" to such interrogations, the
lot would not be able to identify
em, and so some method of selec-
on is required to be built into the
stem.

Instead of a single pulse being
ansmitted, therefore, there are two,
ch of a finite length equal to 2
icroseconds (millionths of a
cond) and capable of separation
time intervals of 4 microseconds.

Twelve such variations are pos-
ble, so that if Channel One consists
two pulses separated by 10 micro-

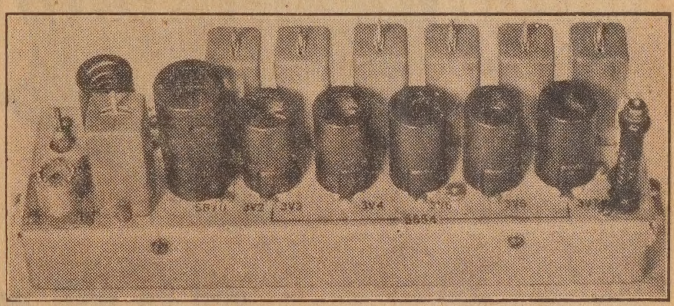


This diagram shows how the DME operates. The transmitter in the aircraft sends out suitable pulses of power from its equipment on one frequency which are picked up by the ground beacon aerial. They then pass through the equipment and trigger the ground transmitter which sends back a pulse which is picked up by the aircraft receiver. The time taken for the pulses to travel to the beacon and return is converted to a distance measurement and displayed on the pilot's indicator dial. In addition a coding pulse is emitted every few seconds to identify the beacon to the aircraft. Note the three-tier aerial array for high gain and directivity.

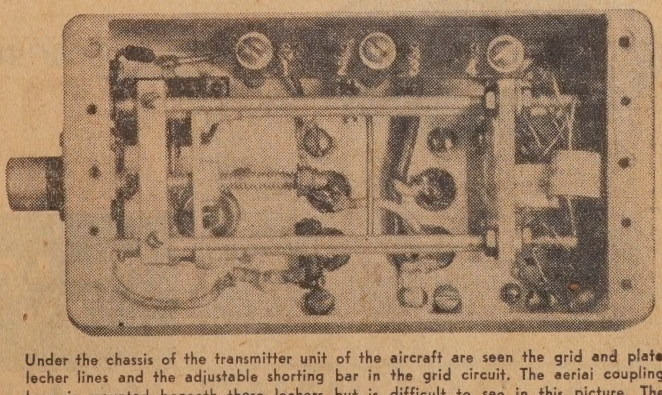
seconds, the minimum separation used, Channel Twelve uses pulses separated by 54 microseconds.

Such small intervals of time might seem incredibly minute to be sustained with accuracy, but with electronic circuits there is no difficulty, although the equipment is designed to cope with a small margin of error.

Each beacon is adjusted to respond only when it receives pulses separated by the correct time interval, which is under the control of the



Here is the complete aircraft receiver — a fine example of compact construction. It may be seen in the picture on the opposite page.



Under the chassis of the transmitter unit of the aircraft are seen the grid and plate lecher lines and the adjustable shorting bar in the grid circuit. The aerial coupling loop is mounted beneath these lechers but is difficult to see in this picture. The push-pull valve sockets are at the right.

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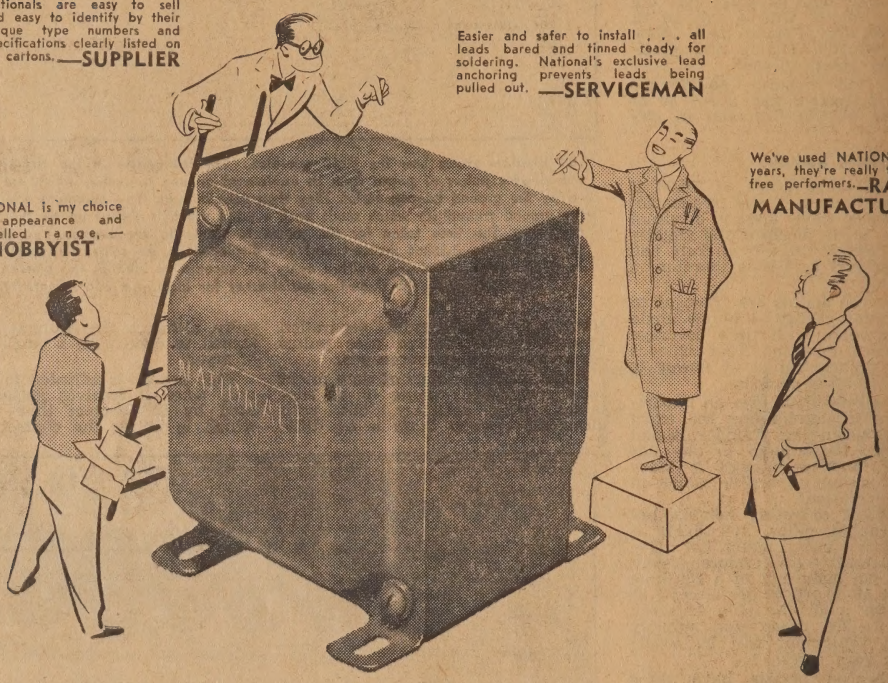

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and selected by a switch on his rol panel.

hen searching for a beacon, he es this switch from one position nother until he receives a reply reference to his list of beacons, nows which one it is which is smitting back to him. The re- se pulses from the ground occur times per second, so that they virtually continuous.

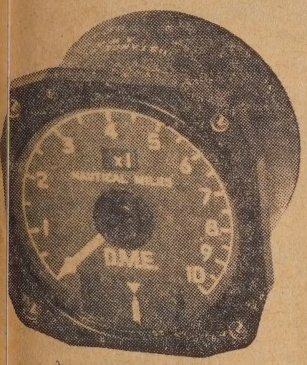
s an additional check, each on transmits a second pulse at rvals of 20 seconds. This pulse ists of a Morse Code signal of letters which identifies the bea- Thus the Sydney beacon would smit the letters SY, and the bourne beacon the letters ML. se may be heard in the pilot's diphones as a 550 cycle note, or by the flashing of a neon lamp.

ACON SELECTION

n practice the pilot usually knows ch beacon to expect along his of flight, and its selection and ntification takes little time and inimum of effort.

t is considered most important t the pilot should have instant ess to the information the equip- nt is designed to give him, and irect-reading indicator is there- e essential.

The output of the DME receiver is arranged to operate a meter, the pointer of which moves over a scale



librated from 0-10 units, repre- nting nautical miles. It has a ultiplier switch to make it read 100 miles, with an indicator to ow when this is in action. Thus ce the DME in the aircraft has en locked to the beacon, it con- nues to show on the dial the exact stance from the aircraft with a us or minus error of one-eighth of mile on the 10-mile range.

RBIT DISPLAY

Sometimes when an aircraft ar- ves at its destination it is re- uired to fly a circular path or orbit a pre-determined height while waiting instructions to land.

DME provides a method of doing his with good accuracy by indica- ng on a second dial on the indicator nit whether the aircraft is flying left or right of an orbit to which e equipment has been set.

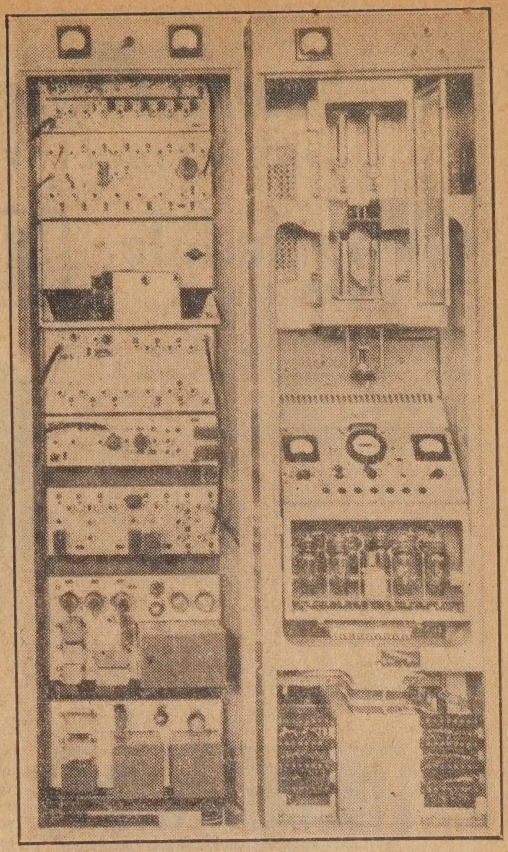
In effect, it indicates any small variation in distance of the aircraft from the beacon, but is a more sensitive indicator than the main dial.

The pilot merely has to fly a course which centres the pointer of the orbit indicator, and automatically he remains on his circular track around the beacon.

The frequency used by the aircraft is 206 Mc, and all aircraft transmit on the same frequency. The beacons, however, transmit their reply and coding pulses on 224 Mc per second. There are good reasons for the use of different frequencies for each.

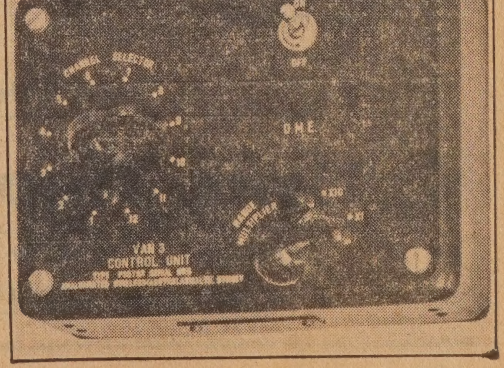
If the same frequency were used, each receiver would be sensitive to reflected pulses from the transmitters which might come from all kinds of objects, including land masses, and these would make the selection of coded pulses liable to interference and confusion. Each receiver, in addition, would receive a very

(Continued on Page 57)



Right: The two racks comprising the ground equipment. The receiver and ancillary gear are in the left-hand rack and the transmitter in the right. Note the 'echer lines and air-cooled oscillator valves of "micro-pup" construction. The power supply is at the bottom of the rack.

Left.—The indicator unit in the aircraft has a scale directly calibrated in miles with a multiplier indicator for ranges greater than 10 miles. The orbit indicator is at the bottom of the dial.



Right.—The control unit as used in a normal airliner has a selector to lock in to the beacon being interrogated and a range switch used in conjunction with the indicator unit for distances up to 100 miles.

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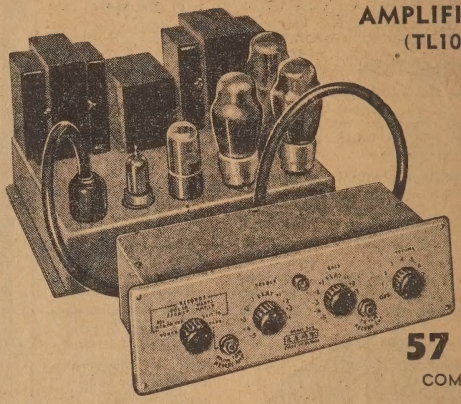

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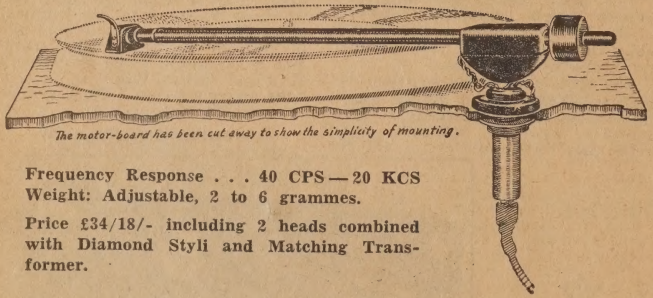

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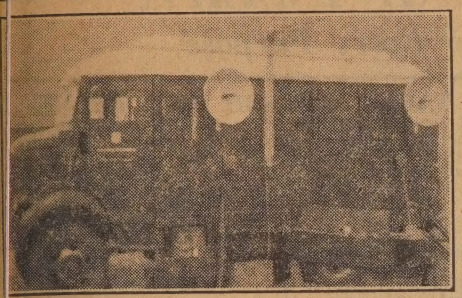

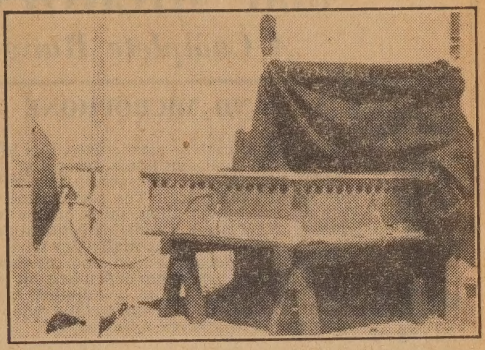

Left—Control truck used by NBS in radio-interferometer measurements of the velocity of electromagnetic waves. Truck contains equipment for monitoring frequencies and measuring phase changes. Antennas used with these systems are visible externally. Right—One of two metal enclosures which housed the VHF radio receivers used in measuring the velocity of electromagnetic waves by phase-shift method. Enclosure also contains 1-Kc band-pass filters, UHF relay-link equipment and a set of storage cells for battery operation of the equipment. UHF transmitting antenna and reflector are visible at left.

Two new determinations of the velocity of light have been made by the US National Bureau of Standards. Although carried out independently by widely different methods, the two determinations give precise values that are in close agreement. They also provide confirmation for the higher values of electromagnetic wave velocity that have been consistently obtained by microwave measurements since World War II.

N one method, the velocity of light was determined from easurement of the molecular conants of carbon monoxide by in-a-red spectroscopy. This work as carried out in the bureau's Washgton laboratories by E. K. Plyler, . R. Blaine, and W. S. Connor.

The other determination made se of phase-shift measurements on ery-high-frequency radio waves obtain their velocity of propaation. These measurements were ade with a radio interferometer y E. F. Florman, of the NBS oulder (Colo.) Laboratotries, on a ry lake bed in south-eastern Arona. The bureau's statistical enineering laboratory co-operated ith both groups in analysing the esulting data, and the NBS high-peed electronic computer, SEAC, ided in the computations.

The velocity of electromagnetic aves has been a subject of inveslgation for many years. In the eriod preceding World War II, the alue 299,776 plus or minus 4 kilometers per second was generally accepted as an average of the findngs of the various laboratories.

HIGHER VALUES

However, since the war higher alues have been obtained by most nvestigators, largely through meaurement of the velocity of propaation of microwaves. Considerafion of this more recent work has ed to an average value of 299,793 lus or minus 1 km/sec. The reults obtained by the bureau give 99,792 plus or minus 6 km/sec by he molecular constants method and 99,795.1 plus or minus 3.1 km/sec y the radio interferometer. They hus provide independent confirmation of the higher values obtained in the other laboratories since World War II.

The molecular constants method was originally suggested by Dr. A. E. Douglas, of Ottawa, Canada. As applied at the bureau it involved measurement of the frequencies not only of lines in the infra-red absorption spectrum of CO, but also of infra-red emission spectral lines obtained when CO is produced in the flame of a burning gas.

SPECTRAL ANALYSIS

Spectral lines corresponding to the rotational states only of the excited CO molecule were already available from microwave spectroscopy. The bureau measured other lines corresponding to both vibrational and rotational states by infra-red spectroscopy. The experimentally determined frequencies of the spectral lines were then used to calculate values of the molecular constants of CO which occur in theoretical formulas for the frequencies. The same molecular constants were obtained in both the infra-red and micro-wave equations, but they were in different units; the micro-wave constants were in megacycles per second while the infra-red constants were in reciprocal centimeters. Thus, the velocity of light could be calculated by taking the ratios of corresponding molecular constants.

The precision of this determination was due in large part to the selection of the CO spectrum for investigation. This spectrum has many spectral lines (both absorption and emission), from which molecular constants can be obtained. Also, the use of flame spectra made for greater precision by providing relatively large values of the rotational quantum number J, which occurs in higher powers in the infra-red equations.

In the course of the experimental work, the wavelengths of 43 rotational lines in the CO absorption band at 4.67 mu were precisely measured using a grating spectrometer and an absorption cell. Fifteen lines in the emission spectrum of CO were also determined. In order to measure the rotational-vibrational band at 4.67 mu to high precision, the fringes of a Fabry-Perot interferometer were used for a comparison spectrum.

The fringes were of visible white light in the region from 5000 to 6000 A, and they were detected in higher orders of the grating with a photomultiplier and an accompanying amplifier. The carbon monoxide lines were detected with a cooled lead-tellurium cell.

COMPLEX PROCESS

The wave numbers of the fringes were determined in reference to the absorption lines by superimposing on the recorded fringe system higher orders of emission lines of xenon, which were detected by the lead-tellurium cell. At low pressures of CO, the lines were sufficiently intense to measure to J equals 23 in the R branch and to J equals 28 in the P branch. However, when a torch burning a methane-oxygen mixture was used to produce CO, the emission lines from J equals 32 to J equals 52 in the P branch could be measured.

The resulting data were analysed

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DESK or HAND MICROPHONE

MIC 36

Housed in attractive plastic case, this Microphone is ideal for home recording and public address, etc. Response unexcelled for its size and price. The performance is not affected by vibration, shock or low frequency wind noise. Omni- directional frequency response substantially flat from 30 to 7000 c.p.s. Recommended load resistance not less than 1 megohm dependent on low frequency response. Can be supplied complete with switch and floor stand adaptor as required at a small extra cost.

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HIGH QUALITY MICROPHONE

MIC 16

Designed to meet even the most exacting requirements, this Microphone incorporates the world famous floating crystal sound cell construction. Its special characteristics are that its fine performance is not affected by vibration or shock. The fidelity is not impaired by low frequency noise.

SPECIFICATION

Recommended load resistance—not less than 1 megohm.
Output level —65 db ref. 1 volt/dyne/cm².
Frequency response—substantially flat from 30 c.p.s. to 10,000 c.p.s.
Directivity—non-directional.
Size—2-1/8in spherical diameter.
Connector—Standard international 3-pin.

£24/19/6

GENERAL PURPOSE

MIC 35

The MIC 35, undoubtedly the best value ever offered, is ideal for amateur transmitters, public address, etc. Housed in an attractive die-cast case, it features a high sensitivity and substantially flat characteristics. Provided with a built-in shunt resistance of 2 megohms, it will, when connected to the grid of the input valve, give a substantially flat response from 50 to 5000 c.p.s.

£2/15/-

SPECIFICATION

Output level: —55 db ref. 1 volt/dyne/cm².
Cable—approx. 4ft. of co-axial supplied.
Weight—6ozs. unpacked, 7 ozs. packed.
Dimensions—microphone only 2¼in x 2¼in x ⅝in.

TABLE or STAND MICROPHONE

This omni-directional Microphone is robust in construction, with a pleasing appearance. Vibration, shock or low frequency wind noise will not affect the performance. The low frequency cut-off is dependent on the load resistance. The cut-off is given by the quotation, F = 80 divided by R, where F = c.p.s., R = megohms. An adaptor (floor mounting) is available at low extra cost.

MIC 22

SPECIFICATION

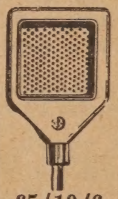
Output level = —50 db ref. 1 volt/dyne/cm².
Output impedance—equivalent to approximately 0.002 uF (0.8 megohm at 100 cycles).
Frequency response—substantially flat from 40 to 6000 c.p.s.
Recommended load resistance—not less than 1 megohm, dependent on low frequency response.

£9/18/6

LAPEL MICROPHONE

Designed to give freedom of movement, this Microphone is small and non-directional. Housed in a soft moulded rubber case, which gives protection against shock, it is provided with a pin at the rear of the case for pinning to the lapel.

MIC 28



Output level—approx. —55 db ref, 1 volt/dyne/cm².
Recommended load resistance—5 megohms.
Frequency response—level throughout the whole of the audible spectrum.
Capacity—0.0015 uF. at 1000 c.p.s.
Impedance—100,000 ohms at 1000 c.p.s.
Cord—6ft. shielded cable.
Size—1-9/16in wide x 2¼in long x 5/8in thick.

£5/19/6

HAND or DESK MICROPHONE

This Microphone has been designed for the high quality public address and home recording field. High sensitivity and flat characteristics are obtained by a specially designed acoustic filter. Housed in an attractive plastic case with an unexcelled response for its size and price. Unaffected by vibration, shock or low frequency wind noise. Omni-directional frequency response substantially flat from 30 to 7000 c.p.s.

MIC 33

£6/18/6

CRYSTAL MICROPHONE INSERTS

MICROPHONE INSERTS

(MIC 32 illustrated)

These inserts are available in varying sizes ranging from as small as 15/16in square to 1-13/16in round, with various thicknesses from 7/32in to 9/16in. Suitable for every purpose such as hearing aids, public address, tape recording, amateur broadcasting, etc., they have responses from 2250 c.p.s. to 3500 c.p.s. at 5 db to 30 db. Insert can be supplied with or without 10 meg. resistor as required.

MIC 32 insert, £2/15/6; all others, £1/19/6.

MICROPHONE INSERTS

(MIC 23 illustrated)

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he bureau's statistical engineering oratory by the method of least ares. The theoretical formula or frequency in terms of molecular stants was fitted to each set of erimental data, and best esti- tes for the constants were ob- ed. The estimated standard iation (plus or minus 6 km/sec) the final value for the velocity light includes an allowance for absolute error as well as an mate based upon the spread in observed data.

DIO INTERFEROMETER

he radio-interferometer measure- nts were carried out on a dry lake in order to obtain a very flat face completely devoid of vege- on for a distance of five miles or re. Essentially the method in- ved accurate determination of the velength of radio waves of a given quency by measurement of a se shift.

After correction for various en- onmental factors, this wavelength s multiplied by the frequency of radiation to obtain the velocity electromagnetic waves. A radio- quency in the VHF range—172.8 gacycles—was employed to avoid r-wave interference, to minimise und effects, and to reduce the ysical size of the measuring system dimensions convienient for stan- rd distance-survey techniques.

Two receiving antennas accurately ced 1500 metres apart were used. varying the position of the trans- tter over a path which half-way circled the two receiving antennas, phase difference between the ivers was made to change. The velength of the radio waves was en calculated by dividing the curately known distance between e receiving antennas by one-half e total change in phase difference.

Even though the radio waves were nsmitted over a flat surface, the lue of wavelength thus determined s affected by the presence of the ound. It was also affected by the mosphere through which the waves d to travel since the velocity of opagation of radio waves depends the index of refraction of the air.

ROUND EFFECTS

Thus, to obtain the "free-space" avelength—that is, the wavelength vacuum—it was necessary to cor- ct for ground effects and for the dex of refraction of the air. ccurately known ground constants ere used to adjust for ground fects while the index of refraction the air was calculated as a func- on of temperature, pressure, and lative humidity.

In practice, transportation of the dio transmitter about the system as avoided by using two trans- itters of the same frequency cated on the extension of the line rough the receiving points; the ange in phase difference at the two ceiving points was then noted when ansmission was switched from one ansmitter to the other.

The only possible source of mbiguity in this experimental rrangement was uncertainty as to e number of 360-degree phase hanges involved in the shift. This ncertainty was resolved at the start f the measurements by moving one ransmitter across exactly one-half f the equiphase contours between he two transmitter positions and noting the change in phase which occurred between the signals at the receiving points.

For convenience, the actual phase measurement was made at an audio-frequency rather than the radio-frequency used for transmission. The audio-frequency was obtained by heterodyning the radio-frequency signal with another signal differing in frequency from the first by 1 kilocycle. The phase changes between the resulting audio signals at the receiving points are identical to the phase changes between the original radio-frequency signals.

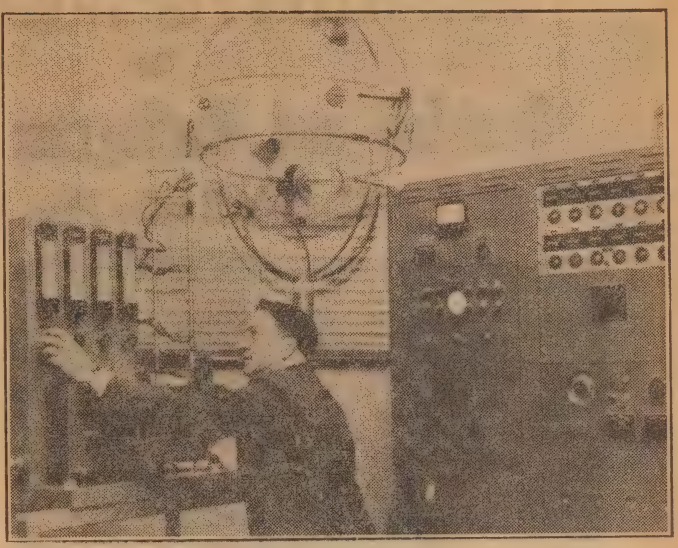
Both the transmitting radio-frequency and the 1-kc heterodyne audio signal frequency were monitored and adjusted against a 100-kc crystal oscillator. The frequency of the oscillator was periodically checked and adjusted to 1 part in 10-million by comparing either its 50th or 100th harmonic with either the 5- or 10-Mc signal, respectively, broadcast by NBS radio station WWV.

STANDARD TAPES

The distance between the two VHF receivers was measured with three standard invar 50-metre tapes that had been calibrated in the bureau's length laboratory. The actual survey and calculation of the distance was carried out by means of US Coast and Geodetic Survey techniques. The standard deviation of the measurements of the distance was two part in 10 to the sixth power.

The final value of 299,795 plus or minus 3.1 km/sec for the velocity of propagation of radio waves in free space was determined as a weighted average of 110 independent measurements made during 10 days. The uncertainty of plus or minus 3.1 km/sec includes an estimated systematic error of plus or minus 0.7 km/sec in addition to a 95 pc confidence interval for the mean value of the measurements.

A DETECTOR FOR GERM WARFARE



Nelson E. Alexander Army chemical corps engineer, adjusting his invention, a device which can give instant warning of germ warfare attack, at Camp Detrick, Md. The device called an aerosoloscope counts germs, dust and moisture particles in the air. Scientists have long been working on the problem of spotting quickly any sneak attempts by an enemy to release germs, radioactive material or a similar substance in the form of "aerosol" cloud.

NEW HYPODERMIC NEEDLE

FOR the prevention of contagious diseases mass inoculations are the order of the day.

Hypodermic needles used for injections during such inoculations have to be sterilised and filled with the vaccine separately for each person. This takes a considerable amount of time, and many hospitals have decided to use each needle only once and discard it. Although saving a considerable time the method is very expensive.

A pharmaceutical manufacturer has now released a new type of needle, called the "manole," which has no such drawbacks.

It consists of a phial with the needle already sealed into one end, and protected from infection by a sealed glass tube. The bottom of the phial is an airtight rubber plug. When it is to be used, the glass seal is broken off the needle and inserted into a special frame. It is then ready for the injection, the rubber plug serving as the plunger. After use the phial and needle are discarded.

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ESTABLISHED 30 YEARS

LATERAL RECORDING USES TAPE

uring the past three years normous progress has been ade in the field of high quality ound recording. Playing time f records has been extended nd surface noise reduced to a ery low level. These qualities re well known to us from the icrogroove records, now freely available.

SC recording, however, is not the only available means of repro- ing sound. Magnetic tape re- ding has also been developed to tage where it is recognised as a n-quality recording medium.

lews has reached us from the Con- nt about yet another means of nd reproduction, combining the antages of the two popular types recording. This new system is subject of the present article.

he operating principle of the new tem is similar to conventional disc ording: A pickup stylus tracks iations in the direction of a ove and converts them to elec- al impulses, to be amplified in nventional amplifiers. There, how- r, the similarity ends.

An endless loop of tape, about wide serves as a recording med- n, carrying approximately 70 oves on this width. Made of a rmoplastic compound, this prac- ally noiseless tape is moved past e pickup stylus at a speed of 45 (or 18in) per second. Manufac- re of this tape alone is a big hievement, although quite good sults were obtained with 16mm ne film in the early experimental ages.

Advantages of this arrangement e not immediately obvious. First all, however, the relatively high pe speed and groove width permit e reproduction of a frequency nge which equals, if not exceeds, ne performance of microgroove re- rds. A substantially flat frequency nge of 30 to 14,000 cycles is claim- d for recordings of this type.

However, a distinct advantage lies the fact that this range is con- ant over the whole playing time up to 70 minutes), unlike ordinary ecords, which show a pronounced ss of high frequency response to- ard the inner grooves.

An ingeniously-constructed self- inding cassette protects the tape at ll times from injury. Only a small oop is pulled out from it during laying. This loop is fitted over capstan, which has a substantial lywheel to ensure a perfectly regu- ar speed. Wow and flutter, the nemies of all Hi-Fi fans, are non- xistent.

Both the capstan and the winding mechanism in the cassette are driven rom a common motor, which also moves the pickup head up and down

Tefifon endless tape record player, with the recording amplifier shown on the left. The cassette takes up to 90ft of tape.

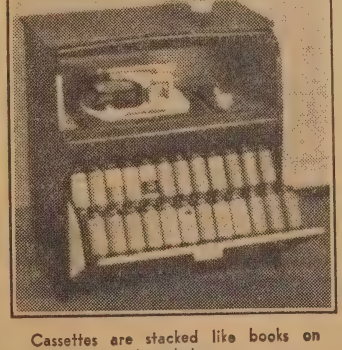
to keep it in the correct position for tracking.

A light-spot indicator coupled to the pickup enables the user to place the stylus into the correct groove, should he want to select items from the program available from any particular tape.

Already a selection of several hundred tapes is available with over 2000 titles.

The cassettes containing the tapes can be stacked on shelves like books, as shown in the picture.

A plastic curtain across the front of the cassette protects the tape during storage to prevent the intrusion of dust. As the playing surface is vertical, and the exposed area small in any case, no significant quantities of dust can settle on the record, thus preserving the noiseless qualities of the tape.



Cassettes are stacked like books on the shelves.

The usefulness of these "Tefifon" players is not exhausted yet. A turntable fitting in place of the tape cassette, and a plug-in turnover pick-up convert it into a conventional three-speed record-player with excellent speed regulation.

Thus, the owner can still play conventional, standard or microgroove records should he desire to do so. A separate record-playing installation is not required.

The extremely smooth running of this turntable demonstrates the high precision with which these instruments are made.

A pre-grooved magnetically-coated tape and a special record-playback head convert the Tefifon into a tape recorder, providing facilities for making one's own recordings.

It goes without saying that a good amplifier and loudspeaker system is required to realise the full possibilities of such an instrument. For magnetic recording, an amplifier-oscillator of the type used in normal tape recorders is also a necessity. The manufacturers have produced a suitable amplifier for this purpose, which can be seen on the left of the machine.

(Remark: To our knowledge, Tefifon record-playing equipment is not available on the local market.)

BEARING TESTS

RAILWAY engineers can now find out in a few days what will happen to their newly-designed ball-bearings, axles, and lubricants after years of all-weather service.

A machine being installed in the Research Centre of the Association of American Railroads can produce the combined long-term effects of load, speed, lubricants, and temperature on wheel actions.

TWO NEW Fluxmaster models

These new versions of Australia's two most popular loudspeakers — Models 5C and 5F — now employ the Rola Fluxmaster principle.

Its introduction in these models has raised their already high efficiency yet reduced their cost to a point where, without question, they represent the best value for money in the 5" speaker group.

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CURRENT CLOSE-UP OF SCIENCE

A friend of mine who happens to be a house-fly is a very keen photographer. He took some snaps around the breakfast-table and then proceeded to ask me about the nutritional value of the various delicacies. According to him, "Every fly-jack would like to know more about the breakfast you humans so kindly provide for us."

By J. GORDON COOK, B.Sc., Ph.D.

"For example," he says, "there's me brown, flinty, sharp-edged stuff at is pretty hard on a fly's feet. Too g a helping seems to keep the lady es awake at night."

Coffee

THAT would be coffee. It contains caffeine, which keeps uman beings awake, too. Caffeine a pretty powerful drug, but it is armless enough in the quantities 've drink.

Scientists have fed rats on diets in vhich coffee is the only liquid drunk nroughout the rat's entire lifetime. 'he coffee-drinkers lived happily and s long as — or even longer than — neir water-drinking relatives.

Toast

TO a fly this is queer looking stuff. It looks like a worn-out ponge or a close-up of the moon. But t is quite tasty — "if you avoid the)lack bits".

Yes I suppose it does look queer n the way a fly sees it. It is just ordinary bread predigested a bit by being cooked under the grill. The noles you see are little craters blown in the bread by carbon dioxide gas.

This is manufactured by living yeast cells as they feed on sugars in the bread-dough. They produce a bit of alcohol as well, but — I assure you — not enough to harm a fly.

Bacon

"WE flies have to be very careful on this stuff because even the steadiest of us can slip and fracture a wing, which is disastrous. Yet it tastes good."

Yes, my friend, bacon does taste good. And it's a favorite home for any fly looking for a well-stocked area in which to raise a family. Maggots revel in the choice fat and proteins they find all around them.

We human beings think pretty highly of our breakfast bacon, too. And we go to great lengths in curing, salting, and storing in refrigerators, to stop bacteria and — pardon me — flies and other insects getting at it before we do.

Pepper

"YOU humans can have this stuff all to yourself. We've tried it, and my, did it make our multiple eyes water! What on earth is it and where does it come from?"

Well, pepper comes from the dried berries of a little climbing shrub that grows in India. We grind up the berries into the gravelly-looking chunks in your snapshot that we like and you don't.

The stuff in pepper that troubles you flies is a mixture of several natural drugs. Piperine gives pepper its taste, while piperidine is the stuff that provides the peppery smell.

Sugar

"MM - MMM! This is really something. Give us plenty of these little jewels with the heavenly taste. What's it called and how do you make it?"

Sugar is made by the green cells of most plants from the carbon dioxide in the air and the water that enters through the plant roots. In the green cells, chlorophyll absorbs energy from the sunshine and turns the carbon dioxide and water into sugars.

Scientists have actually made synthetic sugar in the laboratory, but only enough to satisfy a fly. It's much cheaper to let plants like sugar beet and sugar cane make it for us.

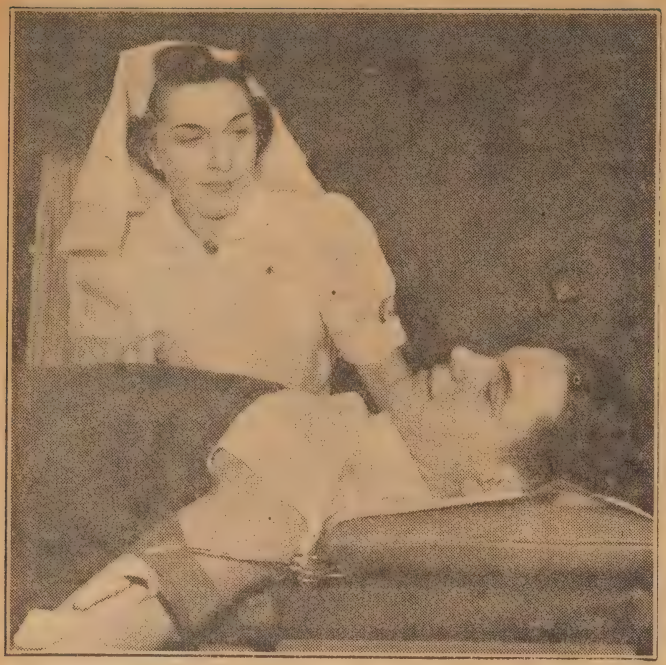
Tablecloths

"THIS stuff seems to be all over the place. We flies see our mothgrub acquaintances tucking ining into it but it seems pretty tough and tasteless to us."

Tablecloths are pretty tasteless and even moth grubs would find this tough going. They tend to stick to wool or fur, which are protein fibres produced by animals.

The fibres in this tablecloth are made from cellulose, which is indeed indigestible. It's the tough material used by plants for constructional purposes. My advice to any fly is to keep off tablecloths and stick to sugar and toast.

THERE'S NO HONEY IN THIS COMB—It is made of aluminium foil bonded between metal sheets to make a rigid, lightweight core easily formed into shapes. Ideal for aircraft it is used by Avro and originally patented by Dornier. A square foot section one inch thick weighs only four ounces.



"It doesn't hurt a bit! Not when you look at me like that!"

OUR BLOOD IS A WONDER FLUID

During the past fifteen years it has been learned that the blood of animals is a much more complicated fluid than was formerly thought to be the case. It performs many hitherto unsuspected functions.

by Calvin Walters

AT one time blood was just something which seemed necessary to keep the body functioning in some way or other.

It was therefore obvious that, in order to make a body cease functioning, it only required that the blood be got rid of in some suitable fashion.

Doing this was quite a pastime in the olden days and, even today, it is fairly widely practised. The only difference is that, in olden times, it was done quite openly whilst today it must be done "under the lap" so to speak, except in time of war.

Detective story writers would be hard put to it, if blood was not such a vital commodity.

MANY FALLACIES

Many fallacies have grown around blood. It is not true that royalty has blue blood in their veins. Neither is it true that one's blood is thicker in the winter than in the summer. It is the same "thickness" all the year round.

That blood is thicker than water is self-evident but quite insulting I think. To speak of the tendency of families to stick up for each other as "blood being thicker than water" can only mean that the person outside the family has water in the veins!

For many years prior to the advent of blood transfusions as we know them today, people who had lost a lot of blood usually died.

The idea of transfusing blood from one living animal to another came first to a chap named Richard Lower, an English anatomist, in 1665. He transfused lamb's blood into a human being.

The first to transfuse human blood into a human was a Frenchman Jean Denis, who siezed upon Lower's idea but, after several successful transfusions, he had an important person die on him.

As is the usual reaction to having an important person die on one's hands, Denis was out of luck. It was all right in those days to have just a person die but an important person — definitely no!

So blood transfusions were thrown into the discard until the 20th century.

In 1900 a Viennese doctor named Karl Landsteiner found that blood was not the same for each individual. It had something in it which made blood from one person not necessarily compatible with the blood of another.

Landsteiner went further and identified the various blood groups in human beings.

If drawn blood is allowed to stand it will divide into two main parts. The red cells will coagulate and form a clot and there will also be a clear amber fluid called plasma which are the white cells and other components. This is sometimes called "serum."

VITAL DISCOVERY

Landsteiner found that there are substances in the red cells which he called agglutinogens and other substances in the white cells which he called agglutinins.

It is these two which cause all the damage between bloods which are incompatible.

In such cases the agglutinogens in the red cells in one blood react with the agglutinins of the white cells in the other blood causing that blood to clot as it were. A person who is full of clotted blood is in a bad way as can be imagined and as our Jean Denis found out.

Landsteiner finally classified human blood into four groups based on the agglutinogen content of the red blood cells. These he called groups O, A, B and AB.

Having found the various groups, it was a fairly simple matter to determine to which group an individual belonged. Thus it was found that groups A and B could be used to test all blood. The procedure is to have at hand serum belonging to both groups A and B. All that is then needed is a sample of the blood of the individual to be tested. This is kept in liquid form by the addition of a suitable reagent.

Serum from the A and B groups are then added to separate batches

the blood suspension. If the red ls are clotted or, to be exact, lutinated by the A serum, the od belongs to group B. If it is lutinated by group B serum it is up A. If it is agglutinated by ither serum it is group O. If it is glutinated by both A and B serum is group AB.

This means then that the blood individuals of the O group con- n no agglutinogens and their blood be transfused into anybody. ey are "universal donors".

Likewise individuals of groups AB ve no agglutinins in their white lls or serum, so that they can re- ive the blood of anybody. They e "universal recipients".

Generally speaking this is true but ere are exceptions which today ve to be taken into consideration hen grouping the blood of any dividual.

It has been found that there are vo types of A blood which are lled A and A2 and two types of AB lood named AB and A2B.

There are also three other gglutinogens M, N and P and an- ther called the Rh factor.

In fact, so much is blood truly ndividual that scores of distinct ypes of blood are identified within he four main groups.

h FACTOR

The Rh factor in human blood s an important one. It is present n approximately 85 pc of individuals rrespective of their group. This neans, conversely, that 15 pc of in- ividuals are Rh negative.

Rh negative persons may become sensitised in various ways so that ransfusions of Rh positive blood an be dangerous to them.

Multiple transfusions may cause this sensitivity. It can also be caused by pregnancy in an Rh negative woman when bearing an Rh positive child from an Rh positive father. If a woman thus sensitised is given a transfusion of Rh positive blood the results can be fatal.

The only blood suitable for trans- fusion in such cases is that which falls within the group compatible with the patient but which is Rh negative.

Rh negative women who have be- come sensitised by pregnancy in the manner described above often form what are known as anti-Rh bodies during the period of gestation of the Rh positive child. These anti-Rh bodies have an adverse effect on the child by producing a serious form of anaemia which can be dealt with only by an almost complete re- placement of the blood of the infant by transfusion with Rh negative blood.

DUE TO ANTIBODIES

It may seem anomalous to trans- fuse Rh negative blood into the Rh positive child. This is done because the antibodies absorbed from the mother continue to persist for some time in the blood of the child, con- tinuing to destroy Rh positive cells.

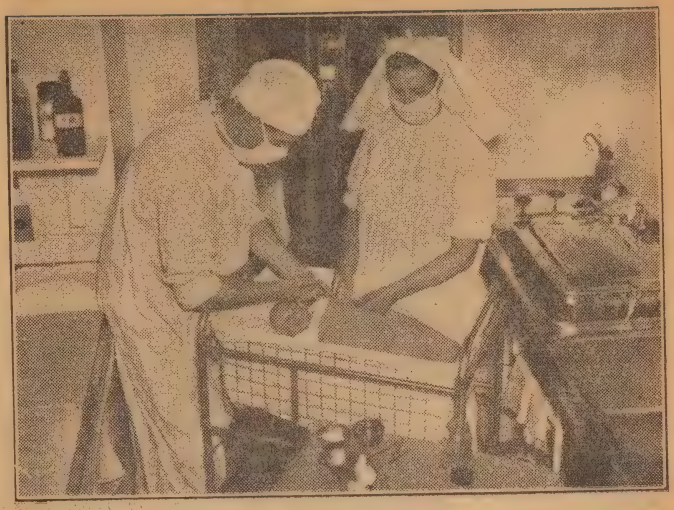
As only 15 pc of the human race possesses Rh negative blood, it will thus be seen that this blood is eagerly sought after by transfusion authori- ties and is very difficult to find.

Blood is a veritable storehouse of many different substances, most of which are valuable in some way to medicine.

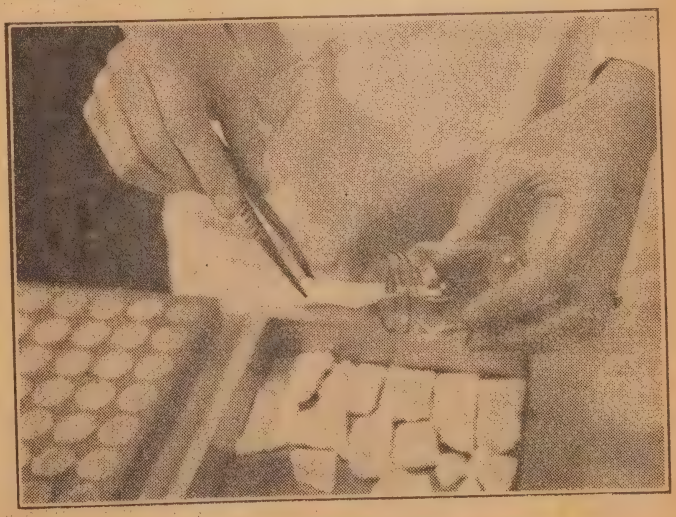
During the past 15 or 20 years it has been found that blood contains 20 enzymes of different types, 10 substances which are involved in clotting, proteins of many different kinds such as fat containing, carbo- hydrate containing, metal containing and so on. Then there are the albumins, hormones, red blood cells, white blood cells, blood platelets, haemo- globin and perhaps many other sub- stances yet unidentified.

Considering the functions of the blood it is no wonder that it con- tains these many substances. Its purpose is to convey to the tissues of the body the necessary raw ma- terials for nutriment such as oxy- gen, food products, vitamins, min- erals and so forth. It also trans- ports away from the body waste products such as carbon dioxide.

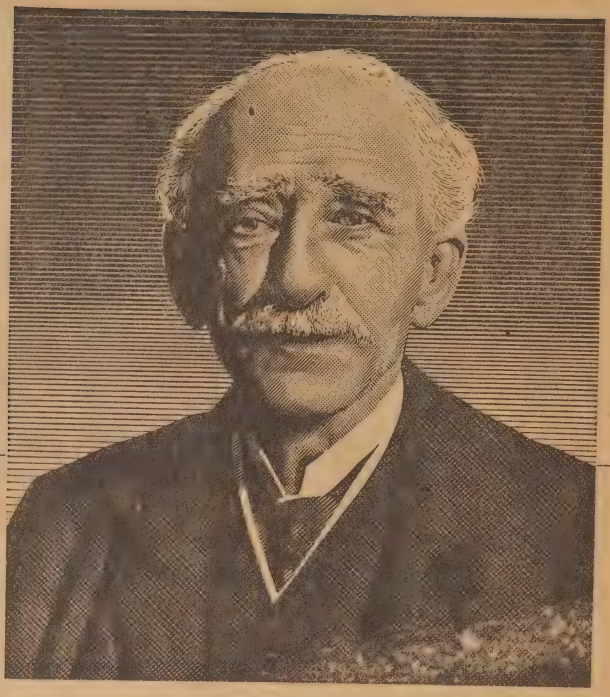
Another function of the blood is to help fight disease, and, for this, the white cells are conditioned for this purpose. In response to an invasion by bacteria, the blood forms antibodies which are concentrated in the form of gamma globulins. These are yet another constituent



Only 48 hours old, yet doomed to die from jaundice, this tiny tot was saved at the King George V Hospital, in Sydney, by a complete exchange of blood.



One of the many "blood products" fibrinogen, is here shown dried into sponge-like substance. Fibrinogen and thrombin are nature's answer to the problem of bleeding and can be used in surgery to make operations safe which were once considered hazardous.



JOHN AMBROSE FLEMING *(1849-1945)—a significant name in the realm of valves and electron tubes—the brilliant Englishman who developed and applied the world's first valve.*

ORA—a significant type number of an early Mullard valve—ORA denoting efficient application as an Oscillator, a Rectifier or an Amplifier! From the early work of Ambrose Fleming in England, through the era of the Mullard ORA to the vast range of valve types to-day is an achievement on which, perhaps, few pause to reflect in our active business of selling valves and service. Through the years, significant has been the contribution of Mullard in research, development, progress and production of this small, intricate and complex device—THE RADIO VALVE. In Australian domestic radio receivers alone there are approximately 15,000,000 in operation.

15,000,000 VALVES. To the Australian Radio servicemen, retailers and wholesalers who help to maintain the three million or so receivers that use these valves let us take the liberty of asking two questions:

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M12

o blood and a very important one,
te.

The amazing thing about this mar-
vlous storehouse called blood is
tht it is continually replenishing
itself.

The important fact arising from
t discovery of the valuable con-
stuents of blood is that blood from
lood banks is being more or less
sted when given whole to many
tients. It has been found that
ly certain portions of blood are
ed and needed by the body under
rtain conditions.

For instance, shock is just as ef-
ctively treated by the transfusion
blood albumin as by the use of
hole blood. In fact, the rest
the blood is wasted on a shock
tient.

Likewise, a patient suffering from
emophilia, the condition which
eates a tendency for a person to
eed, a "bleeder" as he is called,
n be treated with the blood pro-
in fibrinogen.

Then there are the anti-body pro-
ins called gamma globulins, which
e used for injection as protec-
ve agents against certain diseases
ch as measles, mumps and polio-
yelitis.

These are only three of the con-
itions where there is no need for
e use of whole blood. There
e many more such conditions.

Whole blood, of course, will never
e discarded for there are occasions
hen its use is absolutely neces-
ry.

The existence of these blood com-
onents or "fractions", as they are
alled, has led to some interesting
nd ingenious methods for their
eparation.

MMEDIATE TREATMENT

For best results, blood should be
reated immediately it is drawn.
t must not be allowed to clot and
rolonged delay in treatment en-
ourages interaction betweeen the
lood components.

Glass or rubber surfaces assist
lotting because the blood easily
wets their surfaces and wet sur-
aces break down the anti-clotting
ubstances. After many trials it
was found that, if the blood was
passed over a particular type of
esin containing sodium, the blood
will give up its calcium to the resin
n exchange for the sodium. As
alcium is needed for clotting the
blood was, therefore, deprived of
this chemical and would not clot.

The blood must be cooled as rap-
idly as possible, and, for this, it is
passed through a thin-walled plastic
tube about six feet long, which is
suspended in a refrigerated con-
tainer. The blood is now ready
for processing and fractionisation.

First the plasma or clear part of
the blood is separated from the
red cells. This is sometimes done
in a machine like a milk separa-
tor called a centrifuge, but this
damages the white cells and plate-
lets.

HOW IT OPERATES

It has been found that if the
blood protein fibrinogen is added to
blood, the higher concentration of
this protein in some way or other
causes the red cells to pack up
tightly into a mass and separate
from the plasma. In this way about
80 pc of the white cells and plate-
lets can be separated undamaged.

Platelets are again separated from
the white cells in a clever machine
called a falling film rotor. This
consists of a vertical spinning tube
down the inside wall of which flows
plasma in a very thin film. The
centrifugal force throws the plate-
lets through the film, where they
collect on the sides of the tube
while the remaining plasma falls
out of the bottom of the tube. The
platelets are then washed off the
inside of the tube.

To separate the protein compon-
ents of blood, advantage is taken
of the properties of proteins to
interact with metals. They have
an affinity for metallic ions, such
as calcium, copper, cobalt, zinc, iron,
manganese, &c.

Thus, when zinc is added to
plasma, it will throw out a precipi-
tate containing all the gamma glob-
ulins, fibrinogen and fat containing
proteins. These are extracted by
chemical means.

ENORMOUS SAVING

The remaining solution contains
all the carbohydrate containing pro-
teins, the iron globulin and all the
albumin. It has been found that
this solution is ideal for the treat-
ment of burns and shock and is
amazingly stable. It can be kept
for years without refrigeration.

Thus, by fractionisation, blood can
be made to yield its important com-
ponents for clinical use.

This results in an enormous sav-
ing of valuable blood which would
otherwise be wasted, when used in
the whole state, in cases when only
a component is required. It has
also led to the saving of many lives
and the prevention of sickness by
the use of gamma globulins for im-
munisation against some diseases.

A machine is in use in America
for direct treatment of blood as it
passes out of the veins of a donor.
It consists of a complex rotating
bowl of many chambers through
which the blood flows in a continu-
ous stream. By the action of vary-
ing degrees of centrifugal force and
refrigeration the machine automatic-
ally separates the red cells, the
platelets, the white cells and plasma
and when it is stopped all these
are ready in their separate contain-
ers. The force used is very low
and does not damage the cells in
any way.

The important gamma globulins
have been the subject of great re-
search during recent years, and have
proved very useful in immunisation
against certain diseases.

In most cases the immunity gain-
ed is only temporary, but lasts long
enough to ward off an attack.

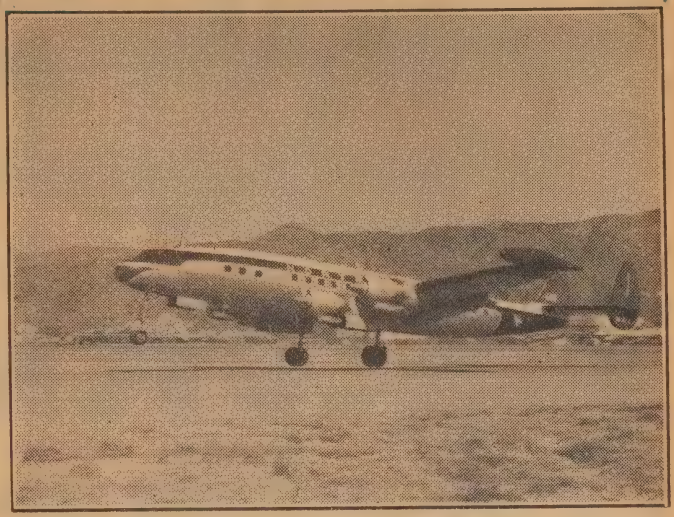
For instance, the measles globulin
can completely prevent the contrac-
tion of the disease for up to 40
days. It has been found, however,
that smaller doses are better because
it reduces the severity of the dis-
ease if contracted to such small
dimensions as to be almost unnotice-
able and at the same time allows
the patient to build up his own per-
manent natural immunity.

KEEPS WELL

Gamma globulin will not prevent
mumps, but gamma globulin taken
from patients who are recovering

(Continued on Page 112)

GIANT AIRLINER TAKES TO THE AIR



Split second photography shows this Super Constellation Taking off with its wheels only inches from the ground. Careful timing was necessary to get this remarkable shot. Note the extra wing-tip tanks for extra range on its long trip between Tokio and Seattle, using the Great Circle route. The aircraft cruises at 330 mph

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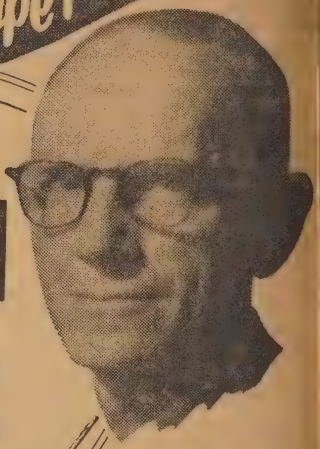

Mr. H. K. R. Thomas, *Chief Sound Recording Engineer at 2GB Macquarie.*

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6. Minimum distortion—maximum signal to noise ratio.

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Technical Review

VARIABLE DAMPING IN AUDIO AMPLIFIERS

ROBERT F. SCOTT
(Radio Electronics)

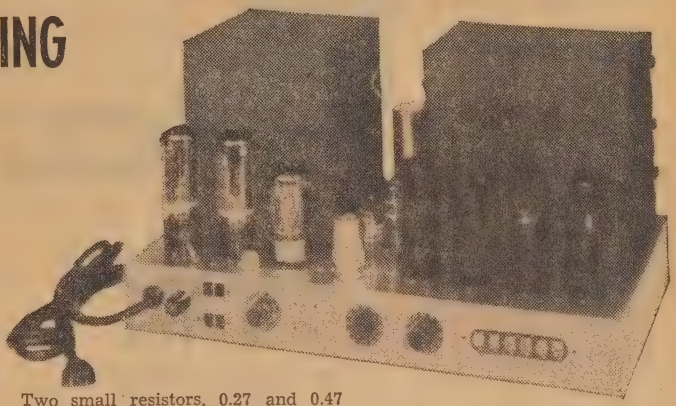
IF I'm ever in the mood for an argument I'll simply make a few categorical remarks about damping factor in amplifiers and then sit back and await the howls of anguish and indignation from those who do not agree.

Rather than chance this, I'll let other authors explain all about damping factor and its effects on speaker performance and just stick to discussing the various circuits amplifier manufacturers are using to obtain an ideal match between amplifier and speaker system.

Circuits for varying the damping factor are comparatively simple and are easily adapted to existing amplifiers.

THE BOGEN DAMPING CONTROL

The variable damping factor control used in Bogen amplifiers is perhaps the most easily adapted to exacting equipment. Fig. 1 shows the circuit of the Bogen DO30A amplifier.



The Scott model 265-A Amplifier.

Two small resistors, 0.27 and 0.47 ohm, are connected in series with the common side of the voice coil circuit.

Since they are in series with the load (voice coil) the voltage drop across them is proportioned to the load current and may be tapped off and used as current feedback. (Negative voltage feedback is taken from across the load and applied separately to the cathode of the first a.f. amplifier.)

A 25-ohm potentiometer shunts the resistors in the output circuit, with its centre arm connected to the bottom of the cathode resistor through a low-pass filter consisting of R1 and C1. When the junction of the series resistors is grounded, the voltage across each is proportional to its resistance. The feedback voltage across the series string is positive with respect to ground at one end and negative with respect to ground at the other.

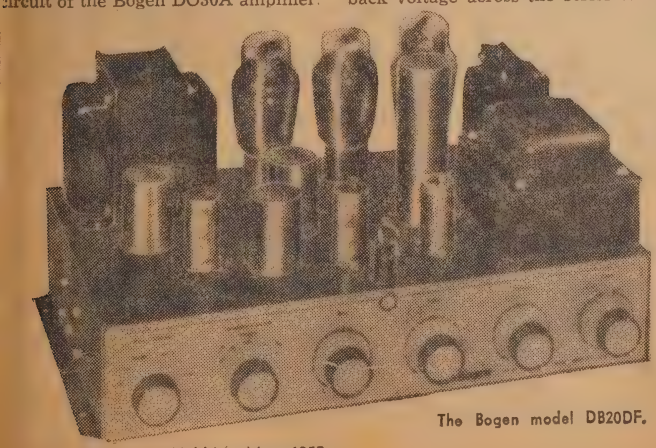
When the control is at its extreme counterclockwise position (X), a ganged switch shorts the series resistors, removing the current feedback. Turning the control clockwise opens the switch so the voltage across the 0.27-ohm resistor is applied to the cathode of the 12AT7 as negative current feedback to increase the output impedance and lower the damping factor.

Continuing the clockwise rotation of the control, the damping factor rises gradually until a point is reached where the arm is at ground potential, there is no current feedback, and the damping factor is the same as when the switch is closed.

Continued rotation of the control applies positive current feedback to the 12AT7, causing the amplifier output impedance and damping factor to become negative. The voltage across the voice coil now varies inversely as the voice-coil impedance.

The low-pass filter in the current feedback loop is designed for a cutoff around 300 cycles to limit the damping to the low-frequency end of the spectrum where it is most effective.

One author suggests making the filter network frequency sensitive to compensate for reduction in low-frequency response when some speakers are provided with optimum damping. In this case, the values



The Bogen model DB20DF.

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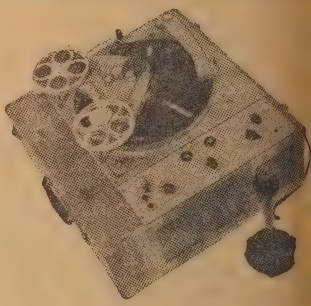

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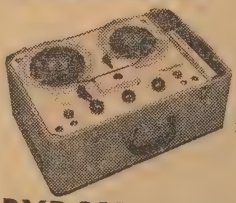
ELCON



Besides the four machines illustrated here, Suttons carry stocks of

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R1 and C1 can be determined from the formula R1 equals 1/6.28 x f x C1, where f is the turnover frequency and may be made equal to the resonant frequency of the speaker.

It is normal for some amplifiers to oscillate when the damping factor is carried into the negative region. So when the speaker-amplifier combination requires a negative damping factor, most satisfactory performance may be found with the damping factor control set just below the point of oscillation.

THE SCOTT AND ELECTRO-VOICE CIRCUITS

In the Bogen circuit (Fig. 1), loudspeaker damping is controlled electronically by using a fixed amount of negative voltage feedback and varying the amplitude and phase of the current feedback applied to the input circuit.

The Electro-Voice and Scott circuits use combinations of negative voltage and negative current feedback only; so they do not provide for varying the damping factor into the negative range as in the Bogen circuit. They are not frequency selective, either.

Fig. 2 shows the variable damping control circuit in the H. H. Scott model 265-A amplifier. The 16-ohm output tap is shunted with a voltage divider consisting of a 1000-ohm potentiometer in series with a 1200-ohm resistor.

The negative voltage feedback signal at the arm of the control is applied to the cathode of the input section of the phase inverter.

A negative current feedback voltage proportional to the voice-coil current is developed across a 0.19-ohm resistor in parallel with a second 500-ohm potentiometer. The current feedback voltage at the arm of this potentiometer is applied to the cathode of the input stage.

The potentiometers are ganged and the voltages are phased so that when the controls are at one end of their range the negative current feedback loop is grounded and the phase inverter gets the full negative voltage feedback.

Rotating the controls toward the other end of their range gradually increases the amount of current feedback and decreases the voltage feedback. The circuit constants are proportioned so the circuit gain and the total amount of feedback are constant for all positions of the damping factor control. The damping factor is variable between 1 and 30.

CIRCLOTRON SERIES

Fig. 3 is the basic damping control circuit used by Electro-Voice in the Circlotron series of amplifiers. A negative voltage feedback signal is taken from the secondary of the output transformer and fed to the arm of an 1800-ohm resistor in the cathode circuit of the first voltage amplifier stage.

The amount of voltage feedback is determined by the values of the cathode resistor and series resistor, and is maximum when the arm of the control is at the cathode end of its range.

The bottom end of the cathode resistor is a 1-ohm potentiometer in series with the common side of the voice coil circuit. The two

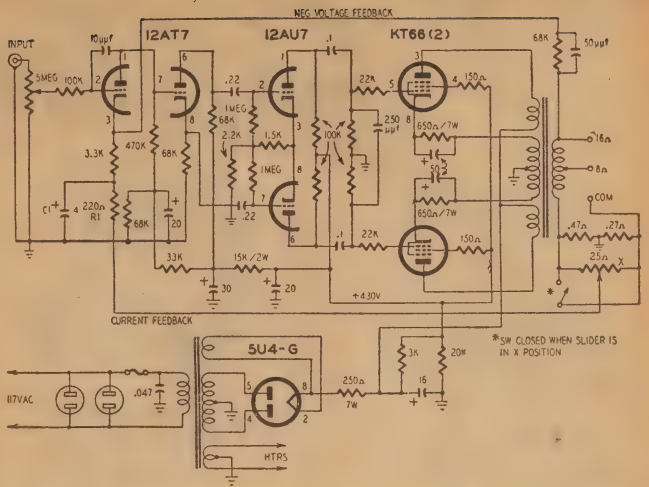


Figure 1: Diagram of the Bogen DO30A with variable dampnig factor control.

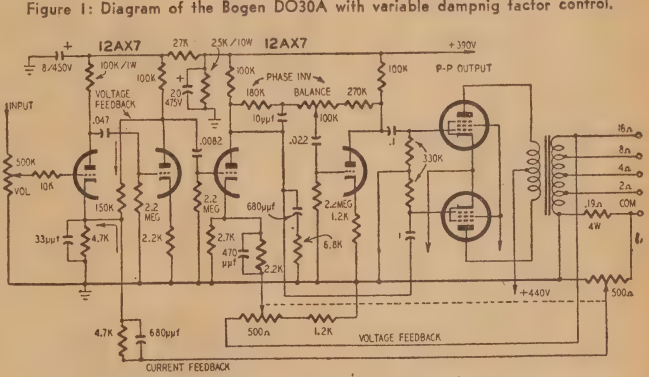
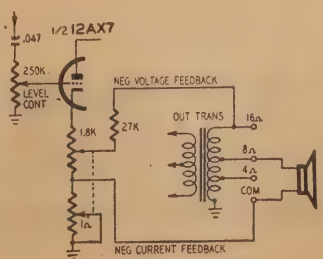


Figure 1: Diagram of the Bogen DO30A with variable damping factor control.

potentiometers are ganged as in Fig. 2. When the control is set for maximum damping factor, the arm of the 1800-ohm potentiometer is at the cathode end for maximum voltage feedback and the 1-ohm potentiometer is shorted out so no current feedback voltage is developed.

Turning the control toward minimum gradually decreases the amount of negative voltage feedback, while the negative current feedback increases as the resistance in series with the voice coil is increased. The damping factor is variable in this circuit from 0.1 to 15.



Electro-voice feedback circuit.

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As phosphates are natural brain "food", no harmful effects can be observed; therefore, the taking of phosphates cannot be described as doping. The explanation is that during periods of intense mental activity the brain uses more than the normal amount of phosphates and they have to be replaced.

EVERYTHING FOR THE RADIO HOBBYIST

Check this page each month

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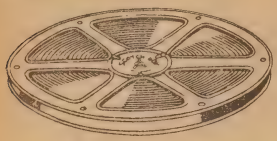

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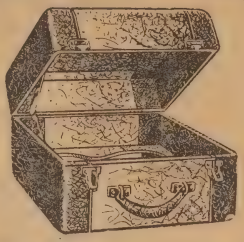

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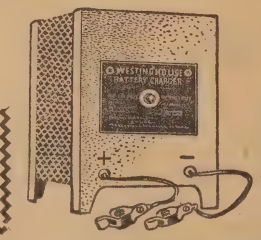

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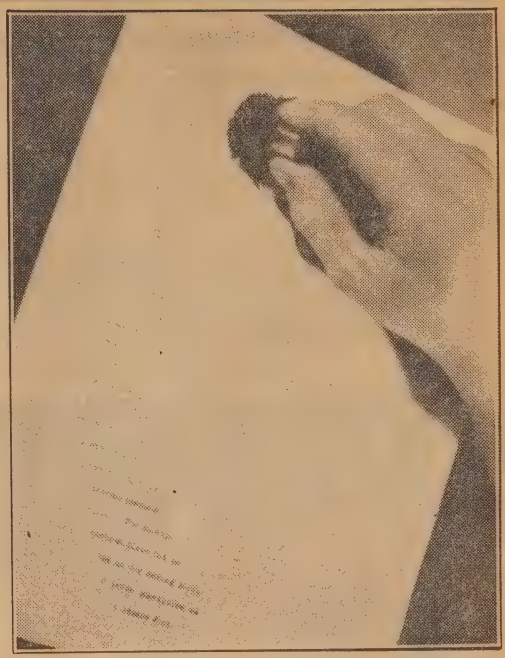
A low-cost, coated paper that is so photosensitive that it can make contact prints at exposures of a fraction of a second has been developed by scientists of the Radio Corporation of America for use in a new, simplified dry photographic process known as "Electrofax".

ALTHOUGH the Electrofax paper is as sensitive as standard photographic contact printing papers, it compares in cost with the low-sensitivity diazo papers in common use for reproduction of diagrams and plans.

Created for use in the Electrofax process for obtaining rapid and permanent prints from photo negatives, microfilm enlargements or projected images, the new paper has proven its sensitivity in numerous tests, including experimental use in a camera.

Picture on the right shows a sensitised sheet which carries the latent "image" of a printed page. Moving the magnetic "brush" across the paper renders the image immediately visible.

☆



The two RCA scientists who were chiefly responsible for the development of the Electrofax process:- C. J. Young (left) and H. G. Greig.

☆

At exposures of one-half a second in outdoor light, it has produced positive prints in a few seconds, with no chemical processing.

The speed with which images can be photographed and printed with the new paper and the Electrofax technique has permitted experimental development of a mechanised system of continuous-strip reproduction that may be adapted to use with electronic computers or other devices which produce a flow of visual information.

The Electrofax process, developed by C. J. Young and H. G. Greig with a team of RCA scientists at the David Sarnoff Research Centre of RCA, in Princeton, NJ, also is regarded as a practical and inexpensive method of producing master copies of letters, diagrams, microfilm records and other documents.

The sensitivity of the new paper has been achieved by applying a thin layer of special zinc oxide in a resin binder. Both materials are inexpensive and readily available.

The coating may be applied to a wide range of papers, from those of low-cost wood pulp base to high strength bond, according to the requirements.

When the paper has been coated, it remains insensitive to light, and hence may be handled without fear of inadvertent exposure, until the coating is given a negative electrostatic charge. The charge is applied in the dark by transfer of ions as a charged wire is moved across the coated surface.

Once the charge has been placed on the layer, the paper is sensitised and must be shielded from light in the manner of ordinary photographic film. The uncharged coated paper, however, will keep indefinitely without deterioration.

EFFECT OF LIGHT

In the Electrofax process, the charged paper is exposed by any of the conventional photographic procedures. The electrostatic charge is reduced in the areas exposed to light, depending upon the intensity of the light, leaving a latent electrostatic image on the coated surface.

The latent image on the paper is developed by applying a pigmented resin powder carrying a positive electrostatic charge which causes the powder to stick to the negatively charged areas on the coated surface.

To accomplish this, the RCA research team developed a magnetic "brush" consisting of a mass of iron filings mixed with the powder and picked up on the end of a permamagnet. The iron particles take on negative charges, while the particles of powder become positive.

When the "brush" is swept across the paper, the image is revealed immediately as the particles cling to the areas of lesser light intensity.

BAKED FINISH

When the "brush" has been swept over the entire surface of the paper, the resulting powder image is fixed permanently by baking the sheet for a few seconds at a temperature which will cause the resin powder to melt and fuse to the coated surface, creating a durable, light-fast picture.

If, for any reason, the image should be unsatisfactory, it may simply be brushed off before the baking process takes place, and the paper used again. After baking, the image is as rugged and permanent as any ink-printed image.

For mechanised operation of the Electrofax process, the RCA team has been experimenting with a large, continuous-strip device and a smaller unit capable of making single prints from projected images.

A rudimentary, portable unit also has been developed with which the process is carried out by hand. Even with the hand unit, finished copies can be produced in a fraction of a minute, from exposure to development of the print.

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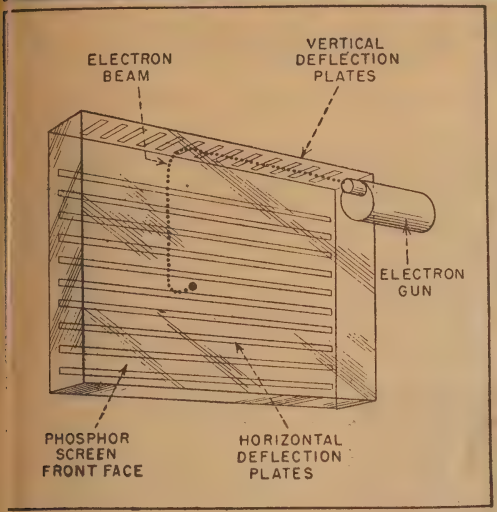
RADICAL STEP IN DESIGN OF TV PICTURE TUBES



Positioning cathode-ray-tube electron gun at side instead of rear of glass envelope reduces tube depth to approximately three inches. Laboratory model of black-and-white version of tube is shown in operation.

The conventional cathode ray tube, as used in oscillographs and television receivers, has one big disadvantage. For any given screen size the length of the tube is out of all proportion. A tube giving a 6in sq. picture may be 16in or more in length. This imposes severe limits on design.

ALTHOUGH this could be reduced to a certain extent by sing power amplifiers in the eflection circuits, there is a efinite limit, beyond which it ould be impossible to go. Many ngineers have believed for some ime that a new approach to the roblem would sooner or later rise.

That is why recent news about n entirely new kind of picture tube as so welcome. The following de- ils were recently published in Elec- onics.

Radically different from conven- ional TV picture display methods, ie flat picture tube developed by ie west coast Electronics Division of Willys Motors Inc. holds promise of evolutionising the TV industry and implifying aircraft instrumentation.

Unlike other proposed designs, the Willys tube does not use elaborate rid switching techniques. It consists f a phosphor screen mounted be- ween two glass plates. The entire nit is evacuated.

The electron beam is injected long a horizontal edge of the tube nd flows in a field-free region along his edge, adjacent to a row of trans- erse deflection plates.

By controlling the voltages on these plates, the electron beam is bent at any desired place along the edge of he tube.

The beam then flows vertically in a second field-free region between a eries of transparent horizontal de- lection plates and the electrically- charged phosphor screen.

By controlling the voltages on the horizontal deflection plates the beam s deflected into the screen at any lesired vertical level.

A raster is scanned by sequential- ly changing the voltage on the trans- verse (vertical) and horizontal deflection plates simultaneously.

All plates are kept at a high voltage except those opposite the position at which it is desired to bend the beam.

Use of electrostatic deflection eliminates the need for magnetic components, with their higher power consumption.

One of the advantages of the new deflection system is said to be a large convergence angle, which solves the beam blow-up problem prevalent in other tubes. Spot size is such that a 2000-line raster might be scanned.

Although the TV tubes shown have 15-inch screens, tubes having useful screen areas comparable to that of 24-inch conventional tubes have been built.

The new tubes have an approximate depth of only three inches in comparison to approximately 20 or more inches for the conventional tubes.

It is reported that progress is being made in developing a color picture tube based on the above principles. Instead of using color dots or strips, the tube might use transparent color phosphors in a multilayer screen, very much like the three color-sensitive layers in some color films.

Such a tube should have no registration problem and would be comparatively simple to manufacture.

Color modulation would be accomplished by changing the relative potentials of the three phosphor layers.

One model of the new tube was adapted by Willys for the navy's long-range program for simpliying aircraft instruments. This program will result in an instrument panel consisting of only two basic instruments, both picture tubes.

One instrument will be a semicircular plate mounted vertically and directly in front of the pilot. It will be transparent and will not interfere with the pilot's vision during contact flight.

Altitude, speed and attitude of the aircraft will be shown on the plate. Physical features such as mountains, which the pilot sees during contact flight, will be depicted artificially.

The second instrument will consist of a round plate mounted below the first just inside the cockpit rim. Its appearance will be similar to that of a radar map. Broad physical features of the earth below will be depicted by analogy.

Calibrations around the rim will indicate number of miles to pilot's base, fuel remaining and similar information.

Because picture tubes are used, several items of information can be selectively superimposed in the same area, to be used as needed.

The tubes will not be used to present an actual picture of what is happening in the vicinity of an aircraft. The display the pilot sees will be an analogy of the visual world that he would see if flying by contact in clear weather.

The first interim instrument panel of the program is soon to be installed in aircraft now in production. The first simplified panel to be developed is now being tested.

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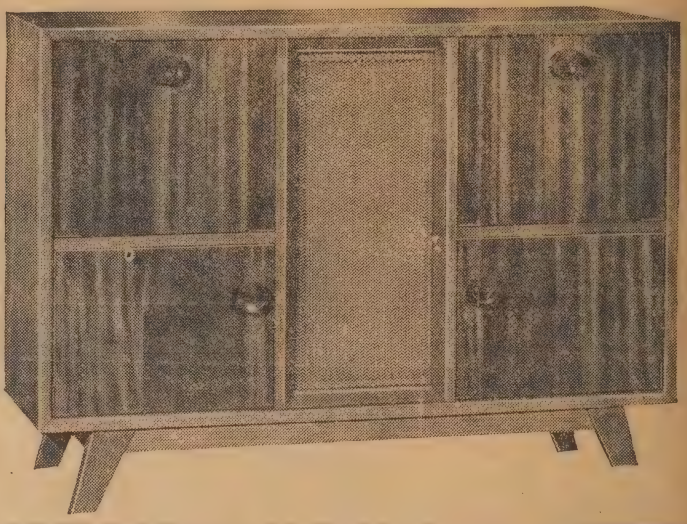


CONTINENTAL

C-79

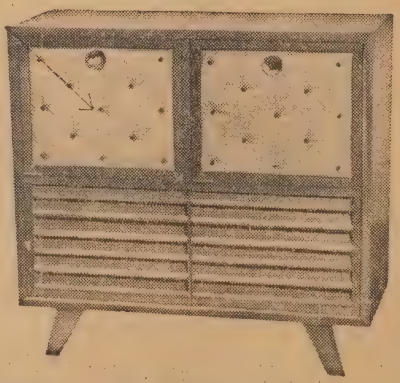
'A magnificently proportioned cabinet in maple veneers, 4ft wide, 35in high and 18in deep, houses this popular 'gram, available with 5, 6 or 8 valves, world-range; 12in speaker; 3 speed record changer. Expanded aluminium grille, with record or glassware storage space on either side increases its appeal.

Models illustrated are latest contemporary styles. Ask also to see the very attractive range of conventional Calstan models.

Calstan

CALibrated to STANdard

RADIOS AND RADIOGRAMS



—another popular Calstan model is the NEW YORKER also available with 5, 6 or 8 valves and other technical features as the Continental, above. The Swedish-style, maple veneer cabinet has studded plastic panels in the very latest trend of today.

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SEE THEM AT ALL GOOD RADIO RETAILERS

NEWS AND VIEWS OF THE MONTH

Glass fertilisers

NEW JERSEY Agricultural Experiment Station has developed a new way of applying fertiliser to deficient soils.

The new fertiliser finds its main application in the field of trace elements which are of utmost importance in agriculture, as has become evident in the reclamation of the 90-mile Desert in South Australia.

Trace elements, such as iron, copper, boron and manganese are fused to glass which is subsequently ground to a fine powder. This can be applied in the conventional manner, or mixed with superphosphate.

Called FTE (Fritted Trace Elements), its main advantage consists in extremely long activity. It guarantees a supply of trace elements for at least five years or more. Slow decomposition of the glass causes release of the required amount of trace elements during this time.

The decomposition process yields soluble compounds of these elements, which are then absorbed by the plants.

★ ★ ★

Super vitamin source

SCIENTISTS working on the island of Puerto Rico in the West Indies found a prolific source of ascorbic acid (vitamin C).

Acerola-cherries, which grow in large quantities on the island, yield as much as 85 times more vitamin than the average citrus fruit.

Commercial production of the cherries is contemplated, as the trees are easily cultivated and improve rapidly in cultivation.

Space travel

THE US Air Force is experimenting with a sealed cabin which could be used in the coming phase of global space flight.

Dr. H. Strughold, chief of the Air Force Department of Space Medicine, said that the experimental sealed cabin was a prototype of the cabin that may be built into future space ships.

However, this type of cabin will be required also when planes begin to fly above 80,000ft. where the ordinary pressurised cabin can no longer supply the pilot with sufficient oxygen.

Sealed cabins have no altitude limit, as they do not relv on the outside air for oxygen supplies. They supply the necessary amount consumed by the pilots from stores within the aircraft.

★ ★ ★

Speed submarine

THE US Navy has an experimental submarine which has proved to be the fastest undersea vessel in the world.

The submarine, Albacore, is reported to have outrun the atomic powered submarine, Nautilus, and even many modern ocean liners.

Her maximum speed remains a military secret, but it is so high that plane type controls are required to operate the vessel below the surface.

Albacore is said to be about 198ft long, weighing more than 1200 tons and carrying a crew of 49.

She was developed to test hull designs and underwater controls for future atomic submarines.

Knife of sound

REPORTS from New York indicate that a "knife" of high-pitched inaudible sound may soon be used in human brain surgery.

Professor W. Fry, of the University of Illinois, announced that doctors have perfected the "knife".

"We are ready to investigate the effects of ultra-sonic treatment on tumerous brain tissues," he said, when speaking to the Federation of American Societies for Experimental Biology in San Francisco. "Neuro-surgeons would be able to use the 'knife' in circumstances which would prohibit normal brain surgery."

★ ★ ★

Color photography

FROM Agfa, Germany, comes the news of an extremely simplified color developing process.

Up to the present such processes involved the use of at least two developing, two bleaching, one fixing and five washing baths for a color positive transparency, requiring handling of film 10 times during the process.

Agfa chemists have now succeeded in developing two solutions, which will take the place of the present process, making the processing of Agfa color film only little more difficult than standard black and white films.

The new process applies, whether positive or negative transparencies or paper prints are required.

By eliminating several drawbacks of the earlier bleaching baths, the new process yields better quality pictures into the bargain.

POPULAR SCIENCE QUIZ

Q. What natural defences has the body against cold?

The body's defence mechanisms against cold include shivering, the constriction of certain types of blood vessels just under the skin's surface (which tend to reduce heat loss) and the increased activity of certain hormones (which provides added heat for the body).

In recent scientific studies, emphasis was placed on the operation of the temperature-regulating mechanism in the brain. This is located in the hypothalamus and controls the shivering of the body.

Shivering, in actual practice begins when sensory nerves react to cold exposure and is "turned off" when muscles involved are called upon in an emergency such as self-defence or flight.

Experiments with animals have shown that shivering could be stopped suddenly by applying an electrical stimulus to a certain area of the hypothalamus.

Q. Is it strictly true to speak of the "silence" of the sea?

No. The sea below the surface tends to be quite a noisy place, according to studies on the sounds made by the inhabitants.

Of 60 North Atlantic coastal fishes "listened in to" with a hydrophone and a sound recorder only six uttered no sounds.

It has been found that fish, like humans, use sounds to contact one another, show fright, or just make a noise.

Some of the sounds produced by the fishes in their natural environment are described as "putt-putts", "thumps" and "clicks". Air bladders or friction of one part of the body against another are the sound producers for the majority of the fish that have been examined.

Q. Is there a treatment for curing "black eyes" quickly?

Something better than the now outmoded steak poultice has been tested with dramatic results for the relief from the swelling, discoloration and painful throbs asciated with black eyes.

According to a recent preliminary report in the Journal of the Philadelphia General Hospital, intramuscular injections of trypsin will take out the pain and swelling within a few hours.

However, the discoloring may last the usual 10 days but can be prevented if the injections are administered within a few minutes of the injury.

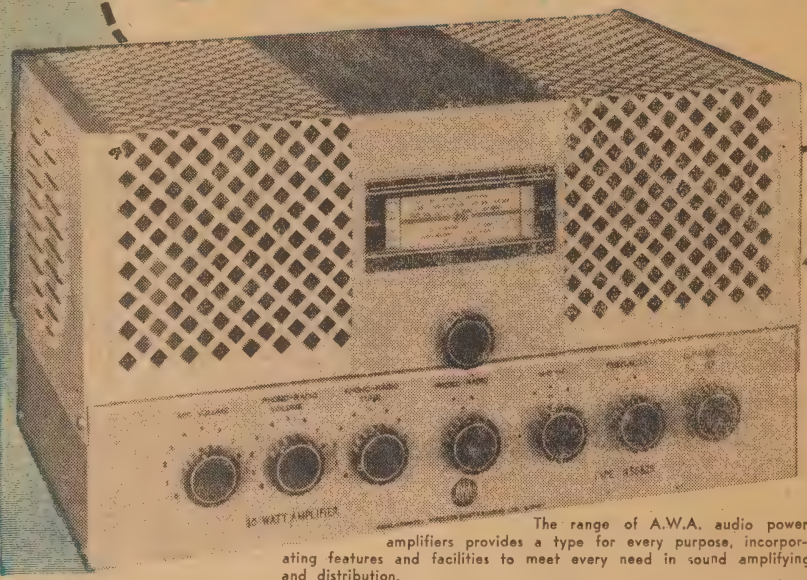
Trypsin is an enzyme secreted by the pancreas to help digest food. It also acts as a catalyst to stir the reactions of other chemicals, necessary in maintaining life.

The injection for black eyes consists of a special purified crystalline trypsin from the pancreas of cattle.

This powerful enzyme acts on the whole body so that the injection is not made to the eye and the delicate tissues around the eyes are not touched.

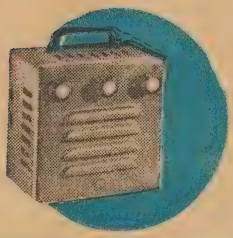
PUBLIC ADDRESS AMPLIFIERS

5 Watt to 70 watt



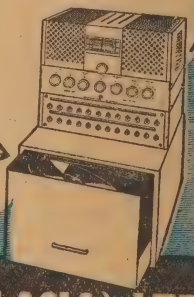
The range of A.W.A. audio power amplifiers provides a type for every purpose, incorporating features and facilities to meet every need in sound amplifying and distribution.

Designed and built to the same high standards of quality workmanship and performance for which the Company has established a world-wide reputation in broadcasting and communication equipment, models PA825 15 watt, PA826 30 watt and PA827 70 watt are illustrated above with radio tuner PA831 fitted. The amplifier protective cover has provision for mounting a monitor speaker.



5 watt portable amplifier type PA806 provides ample power for the needs of most indoor gatherings and many outdoor applications.

Radio, record playing, and speaker switching units assembled with the amplifier to form a centralised system.



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Bad news for pests

A CHEMICAL which promises to be a further milestone in man's fight against insect pests has been discovered recently in Switzerland.

It will be produced commercially under the name Diazinon, although its chemical name, heterocyclic thiophosphoric acid, is as formidable as its effect in the insect world.

Its main advantage is that insects which have become resistant to other insecticides, such as DDT and HCH, readily respond to its effects.

Diazinon is a three way poison. Whether an insect touches it, eats it or breathes its fumes it is lethal for him. Diazinon is absorbed by vegetable tissues, such as leaves and fruit. Consequently its protective effect is prolonged and even rain does not diminish its effectiveness.

The flavor of fruit does not suffer and the compound is non-poisonous for higher animals and human beings.

★ ★ ★

DCA's little black box

FOR the first time in history civil airliners are to be fitted with a special device to prevent crashes due to metal fatigue.

On the recommendation of the Department of Civil Aviation this device, a metal fatigue meter, has been already installed in many airliners, among them being TAA turboprop Viscounts, ANA DC6B Skychiefs and Qantas Super Constellations.

The meter, which looks like a little black box, measures about 8in by 4 in by 4in.

It was developed by the Royal Aircraft Establishment at Farnborough especially for civil airliners. Its development was hurried through following the tragic Comet crashes.

Known as the RAE fatigue meter, it is placed near the airliner's centre of gravity.

There it faithfully records the number of gusts ("bumps" to the normal passenger), the severity of these gusts, and the number of hours the airliner has flown.

In this way scientists can tell when any part of the structure is threatened by fatigue.

The part can then be replaced in good time, before it fails completely —perhaps with fatal results.

Another meter, which, so far, has been installed in only one aircraft in each Australian airline fleet, is even more sensitive.

It will record many more motions which the aircraft may be subjected to in flight.

This particularly applies to the faster airlines, which are subjected more to sudden gusts when flying high, or coming in to land and taking off at speed.

Comet II airliners, which have been taken over by the Royal Air Force for its Transport Command route from Britain to Woomera, are to have these special fatigue recorders installed.

These five or six Comets are having modifications made to windows and fuselage, and are expected to be ready for use on the Woomera run at the beginning of next year.

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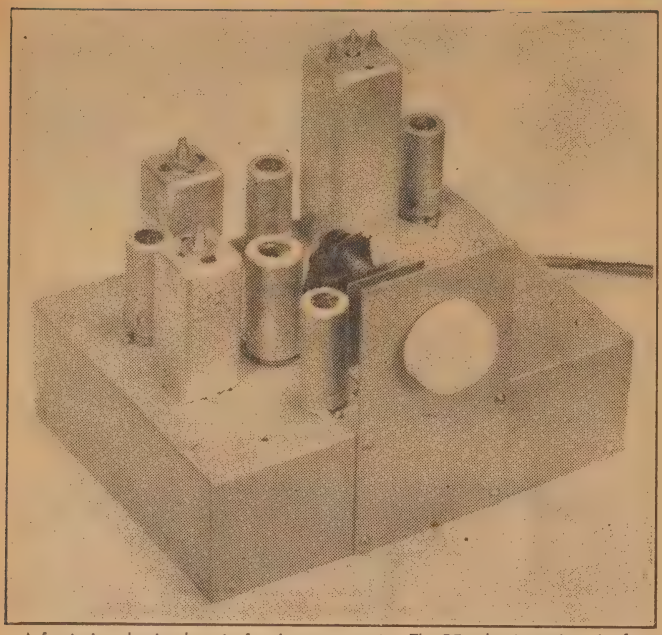


A front view showing layout of major components. The RF valve is against the front of the chassis with the mixer-oscillator behind it. To the left is the 1st IF transformer the remainder of the IF channel running along the rear of the chassis. Note the simple tuning capacitor.

AN FM TUNER FOR PLAYMASTERS

Here is a unit which will make your Playmaster outfit really complete—a tuner to receive the experimental FM transmissions in Sydney, Melbourne and Adelaide. Designed around well tried circuits it is simple and reliable, providing an excellent introduction to FM or VHF.

by Philip Watson

FOR some time now we have been promising ourselves that we would build a new FM tuner. There were two main reasons for this. One was the popularity of the Playmaster Amplifiers and Wide Range AM Tuners which, together with present-day high-quality speakers, have really whetted the appetite of enthusiasts for good-quality radio programs. As a result we have had many requests for an FM tuner to go with the Playmaster series.

TV SOUND

The second reason is bound up with the approach of television. While much time and effort is being put into studying the various complex circuits which are necessary to put a picture on the screen, it may sometimes be forgotten—or, at any rate, mentally pushed aside—that we have to have sound with our picture.

It is almost certain that this sound channel will employ frequency modulation. This being so, it would be wise for the enthusiast who is looking forward to TV to gain some first-hand knowledge of the problems involved. (Incidentally, the use of FM sound is not primarily aimed at providing high audio quality, though this will naturally follow. Its main aim is to make for easier separation of the sound and vision signals in the receiver.)

You may, therefore, look on this project as a dual-purpose one; providing a high quality radio tuner for immediate use with your Playmaster or similar amplifiers, and helping to prepare you, at least in part, for the advent of TV.

At the moment there is only one FM station operating in the Sydne area. This is an experimental on operated by the PMG's Departmer and which derives its programs fro the ABC, the most suitable pro gram items being selected from eithe of the ABC channels.

The radiated power is 2 Kw; th frequency 92.1 Mc, deviation 75 K and the polarisation horizontal. Th normal operating time is from 1 am to 10.30 pm.

There is an identical station i Melbourne operating on 91.1 Mc an in Adelaide on 97.3 Mc.

FUTURE STATIONS

Whether there are likely to b any more stations on this band i the immediate future is difficult t say. Most of the organisations wh would be in a position to operat one are more likely to be concen trating their efforts on TV for som time to come. Nevertheless, the sta tion provides an excellent outlet fo the better-quality musical program for the enthusiast who has th means to reproduce them.

So much then for the general pic ture. We come now to the tune itself. As with the other Playmaste Tuners it is intended for use i conjunction with one or the other o the Playmaster Amplifiers and Con trol Units, deriving its power fro the main amplifier and deliverin audio into the "radio" channel o the control unit.

Reference to the circuit will giv some idea of the general style o the unit. It uses an RF stage, sepa rate oscillator and mixer valves, tw IF stages operating at 10.7 Mc, an a ratio detector. Although designe to operate from the main amplifie power supply there is room on th chassis for its own power suppl if this should be required by a individual constructor.

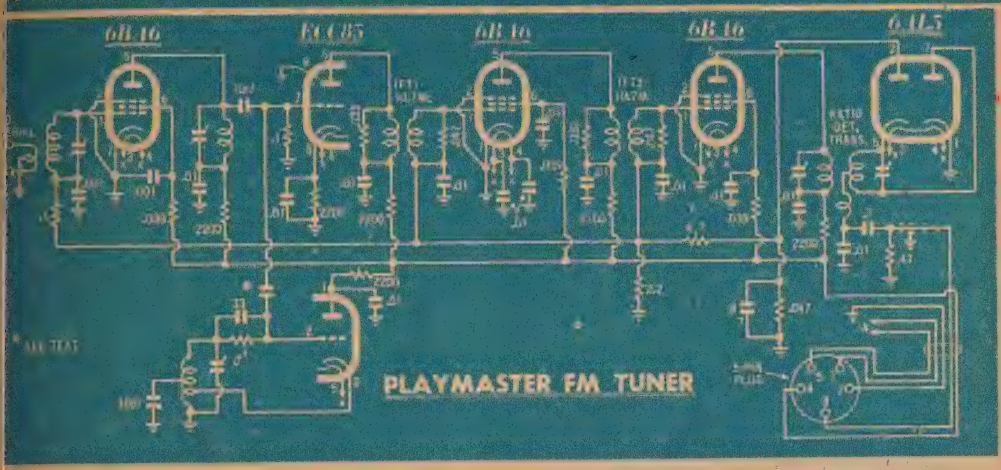
VALVES

The RF stage and the two I stages employ the well-known 6BA valves, the ratio detector is a doubl diode, the 6AL5, and the mixer oscillator is a twin triode, th ECC85.

This latter valve is capable o being used either as a combine RF amplifier and self-oscillatin mixer or as separate oscillator an mixer, as we have done.

The first arrangement appears a attractive one at first glance and w were keen to try it. Unfortunatel it also appears to be rather critica being prone to squeeging, apparentl due in some measure to the charac teristics of the following IF trans former.

CIRCUIT DIAGRAM OF THE PLAYMASTER FM TUNER



The circuit uses well-established techniques and avoids tricky arangments which may trouble the beginner. The .047 meg IF loading resistors can be reduced to .04 meg with improved bandwidth if the lower gain can be tolerated.

This means it could work fine in a commercial receiver where all the critical components could be designed to suit it. However, it shows up in rather a bad light when the problems of the home constructor have to be considered. On this basis we settled for the alternative arrangement which is simpler and more reliable. At a later date we may investigate the other scheme again.

The aerial and RF stages are fixed tuned, the coils being resonated with 30 pf trimmers. The oscillator coil is also adjusted in this way but has, in addition, a two-plate variable capacitor connected across part of its winding to serve as a fine tuning control. With only one station operating there is little point in going to the trouble and expense of fitting a three-gang tuning capacitor when the simpler arrangement is just as effective.

BROAD FRONT END

As it is, the aerial and RF stages are broad enough to take care of any slight drift which may occur and it only remains to provide means whereby the more critical oscillator circuit may be kept on frequency. However, we have left sufficient room and arranged the layout so that a gang could be fitted at a later date if warranted.

The IF transformers need to be loaded with resistors to give them the necessary bandwidth. The values shown in the circuit are about the highest that may be used and may be reduced to give an even broader bandwidth if the resultant gain can be tolerated. .03 across the primary and .04 across the secondary are suggested as alternative values.

It is also essential that there be no trace of regeneration anywhere in this channel, otherwise the bandwidth will be reduced. In this regard it is not sufficient to merely ensure that the channel is stable since it would be possible for a degree of regeneration to exist which, without actually "spilling over", could make the channel too sharp.

To counter this possibility, each stage has its own decoupling network, consisting of a 2200-ohm resistor and a .01-mfd bypass.

The RF stage uses a conventional primary and secondary winding in its grid circuit but uses capacitance coupling into the grid circuit of the mixer. The tuned circuit provides the plate load, a 10-pf capacitor couples to the mixer grid, and a .1-meg. resistor completes the mixer grid circuit.

Coming to the constructional side we find that there are a number of points requiring careful attention. As with any UHF gear, layout is of primary importance and the home constructor would be well advised to follow our original layout as closely as possible.

For a chassis we had ideas about using the same design as for the previous Playmaster Tuners. However, a check on the possible layout showed that this versatile chassis could not serve us on this occasion, mainly because of the need for a precise layout. Thus we were forced to design a new chassis but, for the sake of uniformity, we have made it the same size as the previous ones.

Blueprints of this chassis should be available by the time this appears in print and these will be sent to the various chassis manufacturers in the usual way. Ready-made chassis should thus be available from your dealer within a reas-

PARTS LIST

1 chassis 6½in x 8½in
1 panel 5½in x 3in
1 ¼in to ¼in extension shaft
3 6BA6 valves
1 ECC85 valves
1 6AL5 valves
4 7 pin miniature sockets with shields
1 9 pin miniature socket with shields
1 5 pin plug
2 10.7 Mc IF transformers 1 & 2 (Type J24 or similar)
1 10.7 Mc ratio detector transformer (J25 or similar)

CAPACITORS

1 8 mfd 100v electrolytic
1 .1 mfd 200v paper
7 .01 mfd 400v metallised paper
6 .01 mfd 200v metallised paper
2 .001 ceramic
1 33 pf ceramic
1 10 pf ceramic
5 air dielectric concentric trimmers
1 2 plate midget variable (10 pf aprox.)

RESISTORS

2 4.7 meg. ½w
1 2.2 meg. ½w
4 .1 meg. ½w
3 .047 meg. ½w (see text).
3 .039 meg. 1w
2 .033 meg. ½w (see text).
6 2200 ohm ½w
1 3 terminal tag strip
4 5 terminal tag strip
3 7 terminal tag strip
1 tuning knob
shielded hookup wire
plain hookup wire
75 ohm feeder (K20 or similar)
16g tinned copper wire, solder lugs, nuts and bolts etc.

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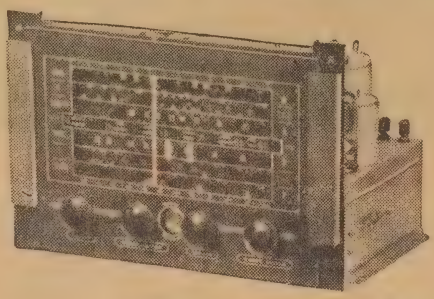
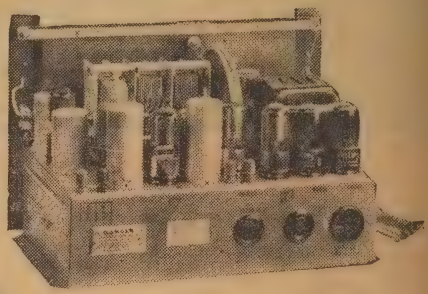
FREIGHT EXTRA





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- Ultra modern circuit with new high gain valves and permatuned iron cored coils and intermediates giving good interstate reception and a short wave range of 12,000 miles.
- High gain audio with push-pull output and tone control gives you high fidelity reproduction from both radio and your favorite recordings. Inverse feedback incorporated.
- Power switch is fitted to the tone control of all chasses thus enabling the power to be completely switched off from the set. Radiogram switch combined with wave change switch.
- Tuning is made simple and positive even on over-sea stations by the use of a super sensitive magic eye tuning indicator.
- All chasses are wired for the fitting of an F.M. or Tape Recorder. Special plug on back of chassis being provided, also standard 3-pin socket for power supply to motor.
- Speakers supplied are Magnavox 12in and 8in permanent magnet with tropic proof transformer.
- Large calibrated edge-lit dial in plate glass (11in x 7in) with main stations in each State in prominent type, fitted with counterweight drive and indicator lights on dial showing which band in operation.
- Dial can be supplied in cream or brown with matching knobs and escutcheon to suit blond or walnut cabinets.

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The ideal chassis for those difficult locations where reception is doubtful

Specifications as nine valve unit but with the addition of high gain tuned R.F. stage giving greater sensitivity and selectivity on both broadcast and short wave bands.

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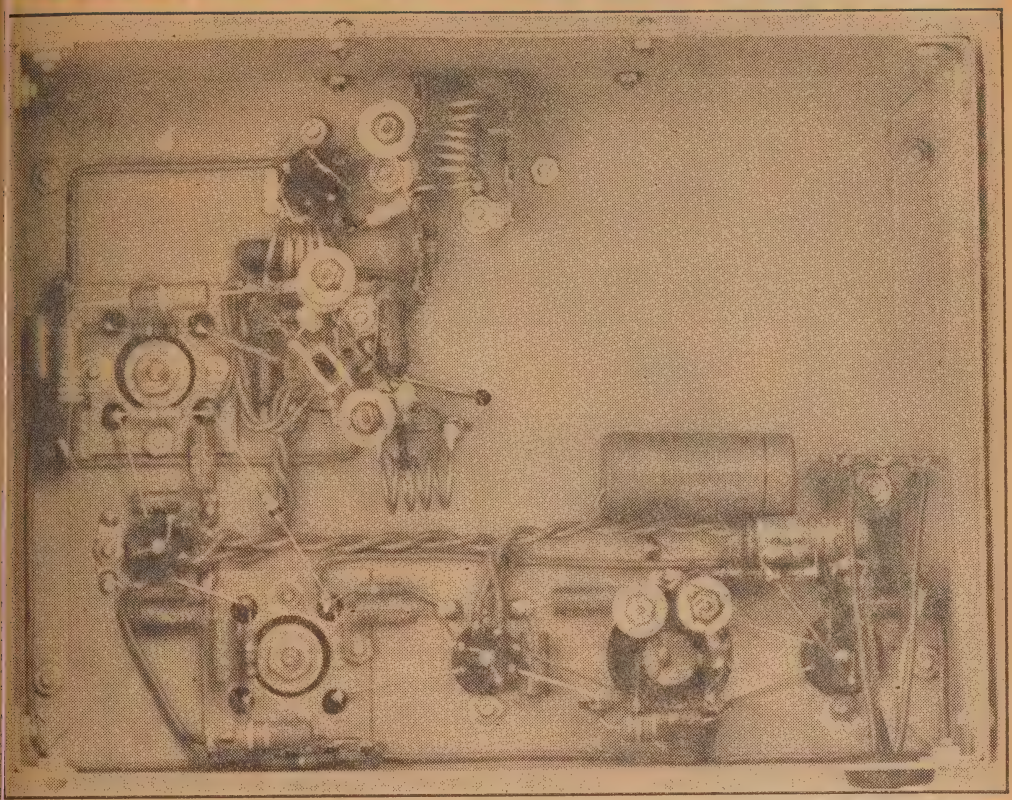
UNDERCHASSIS COMPONENTS ARE SEEN IN LAYOUT



An underchassis view showing the general wiring layout. The aerial coil is near the top centre, the RF coil below and to the left of it, and the oscillator coil below that again. Note the small capacitors which make for short leads and the direct wiring of critical leads.

nable time. Alternatively you may urchase a blueprint and make your wn. Either way, a properly-unched chassis is the first require-nent, since it automatically ensures orrect placement of the major com-ponents.

In addition to the chassis, there s a small front panel measuring in by 5½in and a bracket to sup-ort the tuning capacitor. There is o actual dial, since this is not eeded, a plain knob being suffi-ient.

COMMERCIAL IF'S

In mounting the valve sockets, cor-ect orientation is essential and they hould be fitted as follows, the large ap between pins being used as a eference: 6AL5, to the rear of the hassis. 6BA6 2nd IF, rear of chassis. BA6 1st IF, nearest end of chassis. The ECC85, front right corner of hassis. 6BA6 RF, to front of chassis.

A six terminal tag strip is mount-d under one of the mounting bolts (nearest the filament pins) of the 6AL5. A double-ended solder lug in a similar position for the 2nd IF and RF sockets, and under both mounting bolts for the 1st IF socket. A double-ended solder lug should be provided under both mounting bolts of the ECC85. These solder lugs are specified because, particularly in the case of the 6BA6's, they provide the nearest and most logical earthing points.

Each of the 6BA6 sockets should have an earth wire from pin 7 to the centre spigot, thence to pin 2 and the earth lug. The ECC85 has an earth wire from the spigot to pin 9 and then to the earth lug.

If you are using an aluminium chassis it should be sufficient to mount the solder lugs under the mounting bolts and rely on them to make an efficient connection to the chassis at this point.

In the case of a steel chassis every effort should be made to ensure that the lugs connect to the chassis at the point of mounting and the paint should be removed from a small area around the mounting hole. At the same time an earth wire of bare tinned copper wire should be run between all earth points to provide an additional safe-guard.

The IF transformers and ratio detector transformer should be mounted next and should be orien-tated as follows: Detector trans-former, plate and one diode pin to rear of chassis. 2nd IF, HT and grid pins to rear of chassis. 1st IF, HT and grid to nearest edge of chassis. A five-tag terminal strip should be mounted with all three transformers, using the lug nearest the edge of the chassis.

EARTH RETURNS

These transformers are standard commercial units designed for cir-cuits of this kind. They are avail-able in at least one brand and there should be no difficulty about their availability.

A trimmer of approximately 30 pf needs to be connected across both the primary and secondary of the ratio detector transformer and this is best done at this stage. These and other trimmers are all of the small concentric air dielectric type.

The tuning capacitor is a simple two-plate midget type, preferably of the two-bearing sort. It is mount-ed on a bracket some distance back from the front of the chassis and an extension shaft is used to bring the drive to the front panel.

The wiring may now be com-menced, starting with the filament circuit. Twisted hook-up wire is

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COPPER WIRE
TINNED in 1lb reels
16 gauge .. .. ..

ed and the line runs around the side of the row of sockets closest the filament pins. It is terminated at a three-terminal tag strip ar the 6AL5 socket.

The circuit is not earthed, in accordance with the Playmaster requirements, but it needs to be bypassed from each side to chassis to event hum and oscillation troubles wo .01 mfd., 200-volt metallised aper capacitors are used for this. hey lie on each side of the first sockets and are earthed at the lder lug farthest from the filament ns.

Incidentally, most of the capators in the unit are of the metalsed paper type; 400-volt types for e plate and screen by-pass circits, and 200-volt types for the VC and other low voltage circuits xceptions are the RF stage which ses ceramic types, and the detector age which uses a conventional .1 fd. paper and an 8 mfd. electrotic.

The metallised paper types are ery convenient and their small hysical size make possible very hort leads. It is very desirable that he various by-passes for each stage plate decoupling, screen, and AVC) hould all return to a common earth oint. This is particularly so in he RF stage but is quite easily chieved in the IF stages if the riginal layout is followed.

FM transmissions are normally pre-emphasised in the treble end so that de-emphasis at the receiving end may serve as a further method of combating noise. The .01 mfs capacitor from the tertiary winding to chassis provides this deemphasis and its presence makes it unnecessary to worry overmuch about the capacitance of the audio cable which may be ordinary shielded hook-up wire.

Additional compensation is, of course, available in the control unit to take care of other variables, such as speaker response, &c.

The loading resistors for the IF transformers are most conveniently mounted directly between the terminal pins. Plate and screen resistors for the 1st and 2nd IF stages are mounted on the five terminal tag strips mounted with the 2nd IF transformer and the ratio detector transformer. The tag strip mounted with the 1st IF transformer accommodates the oscillator plate decoupling resistor, screen and plate resistors for the RF stage, mixer plate decoupling resistor, and the .01 mfd. by-pass for this stage.

COIL SUPPORTS

Around the front end of the unit there are a number of tag strips which accommodate the UHF coils as well as several minor components. The oscillator coil is mounted on a three-terminal strip mounted near pins one and two of the ECC85 socket. The strip was cut down from a larger one so that the earth lug was at one end rather than in the middle.

A four-terminal strip, cut in a similarly "lopsided" manner, holds the RF coil and trimmer. Since this coil is in the plate circuit, both ends must be insulated from chassis. This strip is mounted under the ECC85 socket mounting bolt nearest the gap in the pins.

A six-terminal strip (originally a seven, minus one) supports the aerial secondary coil, the trimmer, and the .1 meg. AVC resistor. A four-terminal strip mounted parallel to it holds the aerial primary coil. This makes it easy to adjust the coupling between primary and secondary.

It will be noted that the aerial coil is mounted at right angles to the RF coil, this being done to prevent coupling between the two. If necessary, a shield could be placed between the two, running across the 6BA6 socket between pins two and three, and six and seven. However, we found no need for this in the original.

The UHF coils are home made and do not present any great difficulty. They are wound from 16g tinned copper wire over a 3/8in diameter former and the details are as follows: Oscillator coil, four turns, spaced 9/16in, cathode tapped one turn from earth end, tuning capacitor 1½ turns from earth end.

The aerial and RF coils are both of four turns spread over 3/8in, while the aerial primary is of two turns, spread over ¼in, and centre tapped. If these details are followed the coils should be very close to the original, but they may be adjusted slightly by closing or spreading the turns.

When connecting the trimmers across the coils be sure to connect the frame side to the earthy end of the coil; otherwise there is a chance that they will suffer slight detuning effects when being adjusted. In the case of the RF coil it must be remembered that both sides connect to the HT supply and can deliver a nasty "bite".

For these reasons an insulated, non-metallic, alignment tool is very desirable. We made one from a short length of insulated tubing (actually a length of broken alignment tool) by forcing it over the business end of trimmer after this had been heated to a moderate temperature. Easiest way to do this is to remove the top of a discarded trimmer and sit it on the body of the soldering iron for a few minutes.

ALIGNMENT

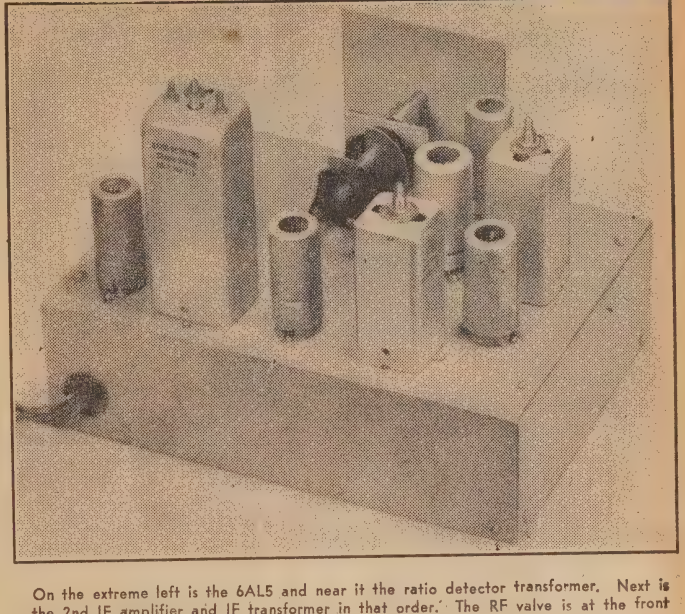
At this stage you should be ready to get the unit working and commence the all important job of alignment. Since the manner in which this is carried out will depend on the equipment you have available, it is hard to give complete details, but the process we adopted will probably suit most workers.

This assumes that an ordinary AM signal generator or oscillator, working to 10.7 Mc, is available. If you do not possess one, it will be well worth while making arrangements to borrow one for this job.

The unit should be connected to the main amplifier and an output meter connected to the latter. Now feed a 10.7 Mc signal from the generator into the grid of the mixer. It should be possible to force a signal through the system even if some of the adjustments are a long way out.

Adjustment of the IF channel is made in exactly the same way as for a conventional receiver, except that the secondary adjustments of the ratio detector (trimmer and slug) are left untouched at this stage. In fact, it is important that they be out of adjustment slightly, otherwise they will tend to reject

REAR VIEW OF THE FM TUNER



On the extreme left is the 6AL5 and near it the ratio detector transformer. Next is the 2nd IF amplifier and IF transformer in that order. The RF valve is at the front of the chassis, the mixer oscillator behind it, and 1st IF transformer to the right.

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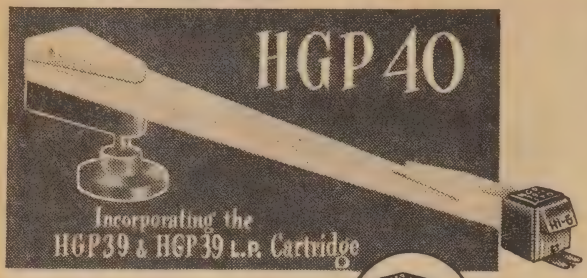

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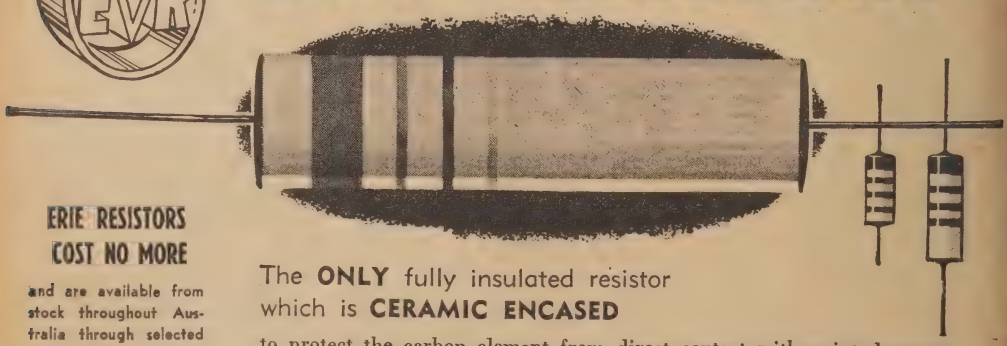

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: AM signal with which we are
rking.
As the various tuned circuits are
ought into line the output of the
nerator should be reduced and
ot at a minimum to prevent the
C from masking the effect of
justments. Go over the IF
annel carefully several times and
eck to make sure that each peak
obtained with the slug in the
rthest out" position.

When you are quite satisfied that
e IF channel is as accurately
gned as it can be, you turn your
ention to the ratio detector. Since
e of the jobs of this device is
reject AM signals, it is reason-
le to suppose that we will get a
nimum signal from our AM gen-
ator when this is correctly adjust-
. This is quite correct and we
ake our next adjustments on the
sis of minimum output.

ALANCE

Main purpose of the adjustment
to bring the secondary tapping
which the tertiary winding con-
cts into the exact electrical centre
the secondary winding. This is
hieved by means of the slug, which
erates in one half of the winding
ly and makes it possible to bal-
ce the inductance of the two
alves.

At the same time the entire
inding must be kept resonant and
ie trimmer is used for this purpose.
is fairly obvious that any adjust-
ent of the slug for balancing pur-
oses will alter the overall induct-
nce and hence the resonant fre-
uency, meaning that the two
djustments will interact quite
arkedly.

This makes it necessary to juggle
ne adjustment against the other
ith a series of trial and error
ettings until both requirements,
e. overall resonance and exact
entre tap, can be satisfied. In addi-
ion, there is likely to be some
ffect on the primary circuit, neces-
itating adjustments here also.
owever, as before, the primary
rimmer is adjusted for a peak,
nly the secondary adjustments be-
ng set for a dip.

Make sure that the generator is
et exactly on the frequency to
which the IF channel has been
ligned and then adjust the trim-
ner until a pronounced dip in re-
sponse is encountered. This point
will be quite sharp and the dip
will be between two peaks. Leave
the trimmer set to the dip and then
swing the generator to each side
of the 10.7 position. Ideally, there
should be a fairly broad peak each
side of the dip, each being the same
width and amplitude.

SLUG ADJUSTMENT

If the peaks are not balanced it
means that the two halves of the
secondary are not balanced and the
slug should be given a new setting,
the trimmer dipped again, and an-
other check made for balance. By
repeating this process it should be
possible to adjust the two peaks
until they are closely balanced, re-
membering that further adjustments
will be possible when the station
is received.

Reception of the actual station is
the next step and, although it is
possible to receive it in favorable
locations using only a few feet of

(Continued on Page 111)

THESE ARE BARGAINS!—

MORGANITE, SWITCH POTENTIOMETERS

A high-grade noise free make with double pole switch. Diameter only 1in. Shaft 2¼in. Available in 0.5 and 1.0 meg.

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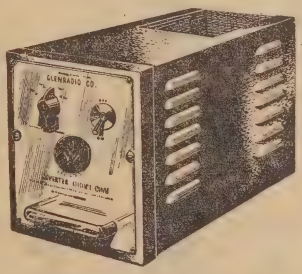

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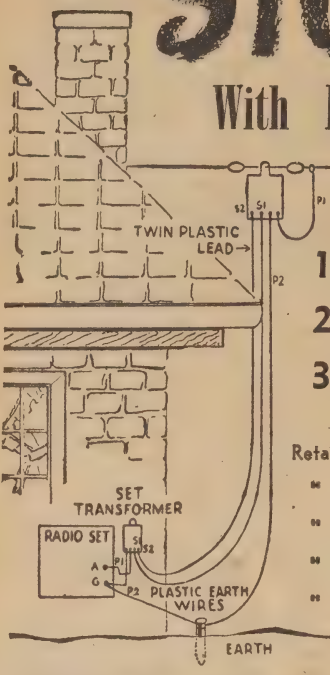

MAKE THIS SIMPLE TEST:—

1. Remove aerial from set. If the noise stops, you need an AF21C aerial filter, as the noise is coming through your aerial.
2. If the noise continues, you need an LF20 line filter as the noise is coming through your power main.
3. If any of the appliances shown below are causing the noise, then fit to it a line filter of the type shown.

Retail AF21C aerial filter	140/-
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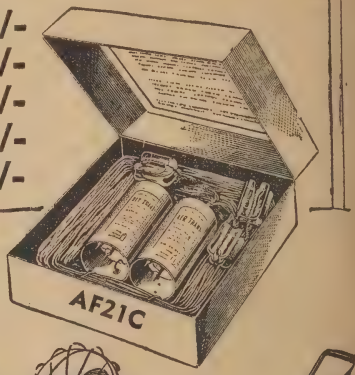
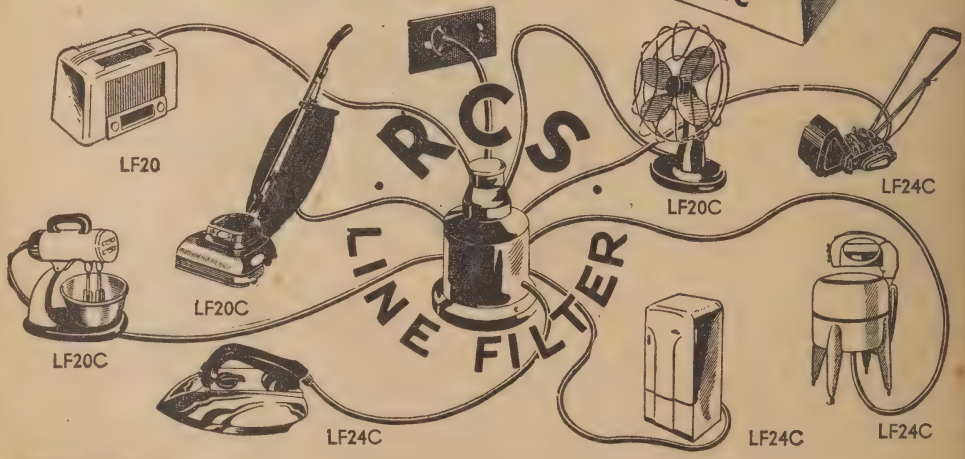
" LF24C " "	55/-



CONFINE NOISE WHERE IT STARTS — WITH R.C.S. LINE FILTER



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FROM THE SERVICEMAN WHO TELLS

If some service jobs are "messy" and difficult, others are equally simple, as in my case, this month. Perhaps it's just as well though, for I shudder to think what life would be if all the jobs were "curly" ones.

UT let's not be too cocky in our remarks. Television is getting comfortably close and not too ny servicemen know even the first ng about it.

However, to get on with my story, set turned up on the counter from client whom I have known for ny years. I have likewise known e set.

It is one of those now-venerable airs, produced during the middle irties, when there was still some ry in owning a "big" set. This e has an RF stage, a dual-wave-m-muting-cum-gramo switch, a rge push-pull audio system and hat was for those days, a de-luxe eaker.

And I must say that it can turn on very good performance, even by odern standards.

OW VOLUME

But now it had stopped—or almost)—the volume having dropped to a hisper.

It had duly and carefully been re-oved from the cabinet, dusted and leaned and delivered on to my coun-er.

All I had to do was to switch it on.

As reported, it tuned all stations, ven on the shortwave band, but only t a whisper. Even the AVC was orking, which looked like a clear ase of an audio fault.

This was confirmed by the simple xpedient of turning to the pick-p position and touching the live ter-minal with the volume control full p. Again, only a very weak sound greeted my ears.

Let's tap a few audio tubes!

The 42 output valves showed no reaction to this treatment at all, nor did the 76 phase splitter. Now for the 75 detector-amplifier.

Even as I moved the tube to take off the grid cap and the top of the valve can, things began to happen. Then a sharp tap on one side of the envelope with a finger-tip stopped the sound altogether.

CRACKLE CURE

A similar tap on the other side produced a crackle and then signals at full volume. After that, nothing I could do to the valve would stop it again. Despite all my efforts and wholesale bumping of the chassis, the set played on quite merrily.

So I checked over the "works" underneath, let the set play on for a few hours and wrote the job off as finished.

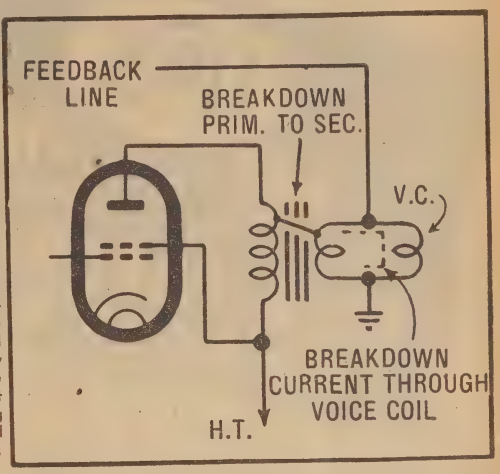
I could have replaced the valve, but I reckoned, on this occasion, that a pensioner client would prefer an explanation to an account.

What then could have happened? Most likely, a fragment of cathode material or metal from somewhere may have lodged between grid and cathode, to be shaken free when I bumped the valve.

This can very easily happen in a high-mu valve like the 75, where the spacing between cathode and grid is very small.

☆

Why the owner thought the set was about to blow up. A breakdown from speaker transformer primary to secondary caused HT current to flow through the voice coil. The effect was worst during the warm-up period when voltage was high.



Once dislodged, the particle can do no further harm.

It may, of course, have been a definite short or open circuit, due to faulty assembly, but I think not. Such faults cannot be permanently cleared by tapping and generally appear and disappear as the valve is bumped this way or that.

My next story commenced when a harassed-looking individual pushed a chassis across the counter to me and practically pleaded, "See if you can do something with this thing, will you? I'll be a nervous wreck if I listen to it much longer."

"What's the trouble?" I asked.

"It goes off bang."

"Come again?"

"The thing goes off with a crack like a rifle shot," he explained. "It's a terrific report really. Scares the daylights out of the missus. She reckons it's going to blow up, and I must say I feel a bit scared myself sometimes."

A little further questioning revealed that these reports nearly always occurred when the set was warming up, though they were by no means confined to this period. Apparently they would continue to occur at odd intervals during the program and for no obvious reason.

The fact that the effect was most apparent during the warm-up period suggested a breakdown of some kind in the HT system, the higher voltage naturally aggravating the fault. A glance at the chassis confirmed that it used a directly-heated rectifier.

TEST RUN

There didn't seem too much point in guessing any farther than this when I had the chassis in front of me, so I set it up on the bench for a test run. It was a fairly standard five-valve console-model type of chassis, the only refinement being a feedback system involving the speaker voice coil. This point became apparent when I set about connecting the set to the bench speaker, the owner having omitted to bring this part of the set.

I switched the set on. It warmed up, then commenced to play, all without any sign of nerve-racking pistol shots. The owner, who had stood by to show me what he meant, shook his head. "It always does it at home," he murmured.

"It could be in the speaker," I explained. "I think you had better drop that in here as well. In the meantime I'll keep it running and see if anything shows up."

And so he departed, promising to call in again the next day with the speaker. I returned to the bench and various routine jobs, letting the set run as I worked. At intervals I switched it off, allowed it to cool and switched it on again, but at no time did it give the slightest hint of the trouble as described.

By this time I was not only convinced that the trouble was in the speaker but I had formed a theory as to the most likely nature of the fault. It seemed most probable that the field coil was breaking down to the frame of the speaker, this apparently being earthed along with the voice coil feedback system. It would not be the first time I had encountered such a fault.

When the owner brought the speaker into the shop next day he stood by again while I made another check. This time there was no doubt about it. Almost as soon as I switch-

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					Ceramic Length	Resistor Body Diameter
MPF	2 watts	500	20 ohms	1.5 megohms	1-3/4"	5/16"
MPG	4 watts	500	20 ohms	1.5 megohms	2"	9/16"
MPJ	5 watts	1000	35 ohms	3.0 megohms	3"	9/16"
MPP	10 watts	1750	25 ohms	2.5 megohms	4-1/2"	3/4"
MPA	20 watts	2750	35 ohms	4.0 megohms	6-1/2"	1-1/8"
MPO	30 watts	4750	50 ohms	5.0 megohms	10-1/2"	1-1/8"
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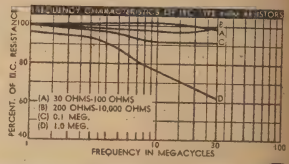

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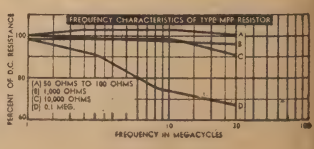


on there was resounding crack
m the speaker, followed by several
re in quick succession. I must
nit I was somewhat taken aback
the violence of the reports. They
re quite ear-splitting and I could
dite understand "the missus" being
red.

After the owner left I attacked the
aker. I checked for leakage be-
een the field and frame, using first
ohmmeter and then a high voltage
rce, but neither showed any sign
trouble. The speaker was one of
type made for easy dismantling,
I slipped it apart in search of
y sign of breakdown. I could find
thing and put it back together
ain.

A test showed the fault to be still
ry much in evidence, thus tending
confirm that it was not where I
d been looking. Now that I was
ced to look elsewhere I began to
ink more seriously about the nature
the sound. It was far louder and
arper than anything I had ever
ard and certainly nothing like
evious HT to chassis breakdowns.
I also noticed that, apart from the
arming-up period, it appeared to
ncide with loud signal passages.

USPECT OUTPUT

Now the only place where there
any substantial voltage generated
y the signal is in the output stage
, more particularly, across the out-
ut transformer. Furthermore, an
ncrease in voltage, relative to the
nassis, could occur at the plate end
f the output transformer due to both
he increased HT voltage during the
arming-up period and an increase
n signal level.

This theory still didn't explain why
ne sound was so violent, but it did
nrow suspicion on the output trans-
ormer. I checked both windings for
ossible leakage to the core, using
imilar methods to those I used for
he field. This test showed nothing,
ut it did give me an idea. Suppose
here was a breakdown between pri-
nary and secondary windings. Might
ot this explain the violence of the
rackles?

I connected the transformer back
nto circuit on the primary side,
eaving the secondary completely
ree from both the voice coil and
hassis connections. Finally I con-
ected a voltmeter from the feedback
ide of the secondary to chassis. (I
ad been careful to note the polarity
f the windings when I disconnected
hem.)

Then I switched on the set, mak-
ing sure that the volume control was
fully retarded. Almost immediately
the voltmeter, set to its highest range,
began making sharp upward kicks,
which continued until the set warm-
ed up. When they ceased I gingerly
advanced the volume control. With
no load on the output valve it could
easily generate quite high voltages
with even a moderate signal level.
Sure enough, the meter began to kick
violently again and I considered my
point proved.

NEW COMPONENT

Final confirmation was provided
by fitting a new transformer, which
completely cured the trouble.

The interesting point, of course, is
why the breakdown caused such a
violent crack. While I was not able
to establish the exact point on the
secondary winding at which the
breakdown was occurring, it seems
reasonable to suppose that it was
at some point away from the earthed
end of the winding and probably
nearer the "hot" end.

In these circumstances any cur-
rent flowing via the breakdown to
chassis would divide, part flowing
through the secondary winding and
part through the speaker voice coil.
Considering the high voltage of the
source and the low impedance of the
voice coil circuit, it is not surprising
that the reaction was violent, even
allowing that the voltage would drop
substantially under load.

And so I was able to return the
set to its owner with the assurance
that "the missus" need no longer
fear a minor atomic explosion.

On an entirely different theme
comes a letter from a reader, Mr.
G.A.B., of Tolga, Queensland. It re-
minds me of the old gag about Edi-
son not being the first man to make
a talking machine; that Adam
should be credited with that distinc-
tion, Edison simply being the first
man to make one that could be turn-
ed off! (Mustn't let my better half
see this, or I'll never hear the last
of it.)

MODERN STYLE

In this case a more modern type
of talking machine, in the form of
a radio, appears to have taken sides
with the fair sex, since it, too, was
unable to be switched off; an effect
which was apparently rather un-
nerving. (Make a good theme for a
whodunit: The Case of the Haunted
Radio, or The Set Which Wouldn't
Switch Off.)

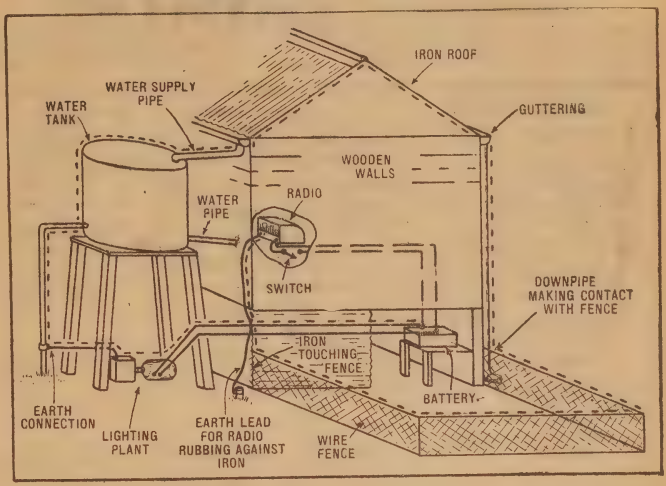
However, enough of this flippancy;
let us to the problem.

Mr. G.A.B., like many other coun-
try folk, has to generate his own
power, using the popular 32-volt sys-
tem, comprising the usual petrol en-
gine, generator and batteries. The
engine and generator were located
in a shed some little distance from
the house and the batteries under the
house.

Naturally, one of the main uses
for the power plant is to operate the
radio, but it was found that this
could not be used while the bat-
teries were being charged, due to
interference from the ignition sys-
tem. In an effort to remedy this,
Mr. G.A.B. earthed the frame of
the engine to a waterpipe.

And then the fun started. The
earthing cured the ignition trouble
all right, but produced a much more
mystifying complication. The set
could no longer be switched off in
the usual way, opening the appropri-
ate switch merely serving to reduce
the volume somewhat.

A preliminary check of the switch



Along the fence and up the drainpipe; over the roof and across to the tank. No it isn't a chase after a cat burglar, merely the round-about-path by which current reached the receiver in this freakish fault. Note the switch in the earthed side of the circuit.

and associated wiring failed to re-
veal any obvious fault and my cor-
respondent admits to a temporary
sense of failure and a fear that the
whole thing was bordering on the
supernatural. For the time being it
was found necessary to disconnect
the leads directly from the battery
in order to silence the radio.

This was effective, but incon-
venient, and it was soon realised
that the real cause would have to
be found; even if it did mean tamper-
ing with the occult.

The first real clue to the prob-
lem was the discovery that discon-
necting the earth wire from the set
cured the trouble. We could spoil a
good story at this stage by finding
that the set was earthed to the water-
pipe. But the truth is, it wasn't. It was
a completely independent earth, such
as is often used in the country when
there is no waterpipe handy. How-
ever, it was a start, and our friend
set out on a tour of exploration to
uncover the rest of the story. It is
best told in his own words:

HIS OWN STORY

"On checking further I found that the earth wire was rubbing on a sheet of iron nailed to the side of the house. This iron was connected to the wire netting garden fence which, after surrounding an area of some 100 square yards, returned to the

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Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

TYPE 920 — 15 watts.
Prim.: 5000, 3000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 897 — 15 watts.
Prim.: 10000, 8000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 896 — 15 watts.
Prim.: 10000, 8000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

SPECIAL HI-FIDELITY

+ — 1 db 20 — 40000 cps.

OUTPUT TYPE
TYPE 870 — 6 watts.
Prim.: 10000 ohms P.P.
Sec.: 2 or 8 ohms.
(for "Rola" 120XY)

TYPE 871 — 12 watts.
Prim.: 10000 ohms P.P.
Sec.: 2 or 8 ohms.

TYPE 872 — 12 watts.
Prim.: 10000 ohms P.P.
Sec.: 3.7 or 15 ohms.

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TYPE 931-15: 20 watts.
Prim.: 4500 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-60000 cps.
Valve: EL37, KT66, 6L6, etc.

TYPE 931-8: 20 watts.
Prim.: As 931-15.
Sec.: 2 or 8 ohms.
Resp.: As 931-15.
Valves: As 931-15.

TYPE 921-15: 20 watts.
Prim.: 6600 ohms P.P
Sec.: 3.7 or 15 ohms.
Resp.: 10-60000 cps.
Valves: 807, KT66, etc.

TYPE 921-8: 20 watts.
Prim.: As 921-15.
Sec.: 2 or 8 ohms.
Resp.: As 921-15.
Valves: As 921-15.

TYPE 916-15: 12 watts.
Prim.: 8500 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-50000 cps.
Valves: 6BW6, 6V6, KT61, etc.

TYPE 916-8: 12 watts.
Prim.: As 916-15.
Sec.: 2 or 8 ohms.
Resp. As 916-15.
Valves: As 916-15.

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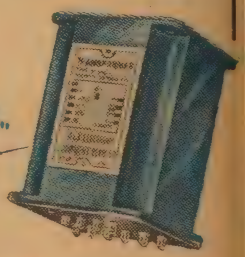

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LOOK FOR THE SILVER-GREY TRANSFORMER

use at the opposite corner and, ile being nailed to a house post, o rubbed against a downpipe."

The downpipe was in turn con- ted to the roof guttering and this ched the corrugated iron roof. The f touched a different guttering on other side of the house and which s our rainwater tank through a inpipe about five yards long. This nwater tank connects to the pipe which I coupled the lighting plant gine, to cut out the ignition inter- ence.

The final connection back to the teries was made through one of generator leads. The actual one never bothered to find out, as I 's getting a bit sick of it all by this ne. I presume it was the (gener- or) earth terminal.

"That all these connections were blame was established by oriously unnailing wire netting d pulling apart various bits of wnpipe. What was most remark- le was the fact that quite a few them were only made by one piece iron rubbing on another and not ing fixed in a solid manner.

"What makes it all the more asperating is the difficulty I have id to get sundry 32-volt appliances work satisfactorily at any rela- vely long distance from the bat- ry, with the best of soldered con- ections, without using a copper ire of tremendous diametrical pro- ortions."

So there it is, and my sympathies Mr. G.A.B. on the seeming paradox the radio which would work on e roughest of connections and the ppliances which would not work on e best.

CURRENT DRAIN

In comparing the accidental circuit vith the properly designed one there re one or two interesting points. n the first place the current require- nents of a radio would be very much ess than that of most appliances, lus the fact that most sets will work ver a fairly wide range of voltages, particularly if one accepts a lower performance, as in this case.

Then again, while many of the connections may have been rough, here was probably very little loss n the various conductors themselves, lue to the relatively large cross sectional area. Even the wire netting fence was probably equal to a fairly neavy gauge wire if one were to add together all the available conductors. The downpipe would do a pretty good job, too, while the roof would have almost zero resistance.

It is also quite probable that the connections were not as bad as might be imagined. A galvanised surface will make quite an efficient connec- tion, and when one considers the fairly large surface available for contact between two pieces of down- pipe it would not be surprising if the resistance was quite low. Of course, if any rust was present it might be a different matter.

LEAD RESISTANCE

In the case of leads to operate heavy duty appliances there is usu- ally no great problem regarding con- nections. These can be soldered or securely clamped and will give little trouble. The real problem is to pro- vide a conductor which will have a low enough ohmic resistance to pre- vent intolerable losses.

After all, a 500-watt appliance (not an unreasonable size, I imagine) would draw 15 amps and have a resistance of approximately 2 ohms. In order to avoid serious losses it would be necessary to keep the total resistance of the line, including switches, &c., to some small fraction of this value, say one-tenth or better.

Referring to wire tables, we find that 16 s.w.g. has a resistance of .25 ohms per 100ft, making possible a run of 50ft with this gauge of wire assuming that there were no other losses. Since there probably would be other losses, something less than this distance might be necessary.

Alternatively, a heavier gauge of wire would be necessary, but this is where things start to get bulky—and expensive sometimes—though there is little alternative solution.

The other question which might arise out of the story is why the presence of the various freak con- nections caused the switch to be- come inoperative. It is fairly obvious that the switch was, quite by chance, wired in the earthy side of the cir- cuit. (The side of the circuit connect- ing to the frame of the generator.) Until the frame of the engine and generator were deliberately earthed this did not matter very much, but it became very important when this was done.

The correct arrangement is for the switch always to be in unearthed (active) side of the system and never in the earthed (or neutral) side. This arrangement has nothing to do with the polarity of the system in the case of DC.

As far as low voltage systems are concerned the only probable result of not observing these requirements would be some funny (funny-pecu- liar, not funny-ha-ha) effects similar to those which worried Mr. G.A.B. Because of the low voltage it is not likely that there will be any real danger.

DIFFERENT STORY

However, when dealing with the mains, or even a 110-volt lighting plant, it could be quite a different story. This fact was brought home to me quite forcibly by a recent occurrence to a friend and which was related to me by him.

This friend is rather fond of tinker- ing with things in his garage, for which purpose he has installed a workbench, a couple of overhead lights, a trouble light, plus a few odds and ends like an electric drill, a soldering iron, a small air compressor, and so on.

Faced with the problem of using all these things from a single power point, he considered himself "in luck" one day when he picked up from somewhere or other a multiple output board.

Most of you are familiar with the idea. It generally consists of a standard electrical type wood block on which is mounted as many outlets as may be required along with any switches which may be needed to control individual out- lets. It is fitted with a length of cab tyre cable and a three-pin plug which plugs into the normal power point.

In my friend's case there were three outlets which connected di- rectly to the power point and three more which were controlled by in- dividual switches. For his par- ticular requirements this was a per- fectly satisfactory arrangement. The unswitched outlets were used for appliances which needed to be "on" continuously, at least while the workshop was in use, and which could quite conveniently be con- trolled by the main power point switch.

The switched outlets provided an extra measure of convenience, but my friend had no illusions about their possible limitations. He was well aware that there was a fifty- fifty chance whether they were in the live side of the circuit. (where they should be) or in the neutral side (where they shouldn't be).

In no circumstances would he have relied upon them where any question of safety was involved. For this, nothing less than the unplug- ging of the board would suffice or, if the main power point was in- volved, the removal of the main fuses so as to positively open both lines.

ESSENTIAL RULE

This rule is really essential for anyone in the habit of working on mains wiring. Don't, in any cir- cumstances, rely on any single pole switch to render a line safe. A double pole switch, as normally used for a main switch, will effectively kill the line, but it is not a bad idea to remove the fuses as well, if they are the pull-out variety.

But to return to the particular case. Everything went along smooth- ly until my friend had a visit from his in-laws (I didn't bother to dis- cover the exact relationship, suffi- cient to say that Pa and Ma were spending a few days with the young folk).

The first spot of bother occurred when Ma tackled a pile of ironing and found that the iron was be- having poorly and giving forth spitting noises. She promptly hand- ed it over to Pa, with instructions to put the thing back into work- ing order.

Now Pa is probably what one may term an average handyman. He can fit a fuse, repair a defective cord, fit a new jug element, and carry out similar jobs with commend- able efficiency. So he simply took the iron into the workshop, plug- ged it into one of the switched outlets, switched it on and observ- ed that Ma had, indeed, been right.

(Continued on Page 113)

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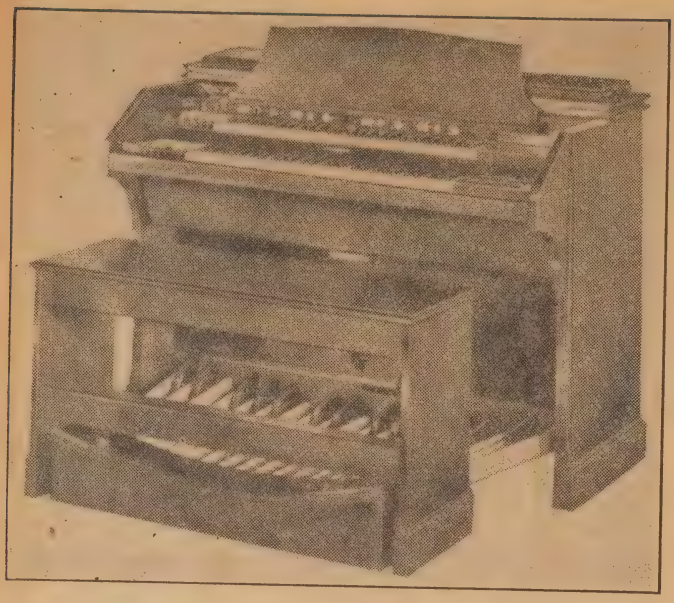

A typical model of the Hammond organ, perhaps the best known and most contentious of all electronic instruments. Though referred to as an organ, it is best regarded as a new and rather unique instrument which has certain organ-like qualities.

SURVEY OF ELECTRONIC MUSIC

One of the most fascinating subjects in the whole audio field has to do with the generation of musical sound by electronic means. In this two-part article, the author discusses the nature of sound, the design of simple electronic instruments, progressing finally to a survey of full scale electronic organs. It is, in fact the article that many readers have been waiting for.

PART 1—SOUND AND HOW IT IS SYNTHESISED

ELECTRONIC musical instruments. What are they? Well, they all have one thing in common—their sound is heard through a loudspeaker.

As for classes and types, it is not so easy to give such a simple answer, and it might be as well to work around and about the subject, so that the reader can see just what is the present stage of this branch of electronics.

Best known of all electronic musical instruments is the Hammond Organ, in its different models. As for its merits and demerits in being named an organ, that is a facet we can go into later, but the fact remains that production reached the five figure mark many years back.

Also, there are in production a number of other instruments of a like class and, when one thinks of electronic music, the mind seems to turn automatically to organs.

However, we must not forget the electronic guitar—more popularly referred to as the electric guitar—great numbers of which have been manufactured and sold.

These instruments pick up their tones in three main ways. The first is the simple, but not entirely satisfactory, method of clamping a microphone to the body of the guitar and amplifying the output of the microphone.

The other two methods, in which the direct sound from the strings is purposefully muted, is to pick up the vibrations from the strings by electrostatic or electromagnetic means.

In the electrostatic method the strings, which are at earth or a negative potential, vibrate very close to a plate on which there is an applied voltage—usually of the order of 300 volts.

Nearly all the commercial instruments using this method have one such high voltage plate to each string, the vibrations of each string over its particular electrostatic member generating an oscillatory voltage, which is fed into an amplifier connected to the device.

HOME EXPERIMENTS

This system, which may be likened in principle to a condenser microphone, is very simple to get going and is ideal for the home experimenter.

As far as commercial production is concerned, the electromagnetic method is the more usual. In this type, the electronic guitar appears to be the same as the electrostatic, in that the strings are muted but, instead of having high voltage electrodes adjacent to the strings, each string has a small magnet near it. Around the magnet is wound a coil, in which a voltage is induced when the strings are set in motion.

Besides guitars, there are also electronic violins, banjos, ukuleles, violas, bass fiddles—in fact anything with a vibrating string. If the strings are of gut or non-magnetic material its is usual to coat or cover the strings, at the point of pick-up, with a ferro-magnetic encasement.

With the foregoing instruments it is common practice, because the output from the pick-up device is usually low, to provide a stage of preamplification, then to insert a volume controlling device. This volume control, more often than not a potentiometer, may be varied by hand or foot.

Foot control is preferable because it leaves both hands completely free and, as a consequence, more facility

BY R. A. B. TARRANT

available for expression. Sudden nges to forte or pianissimo may achieved without interference h the standard playing tech- ues.

rue, a certain variation in vol- e can be obtained by suitable gering or bowing but the namic range available is nowhere r that obtainable with an ex- ssion control.

By judicious placement of micro- ones, it is possible to amplify most every musical instrument, t, in doing so, the device does OT become an electronic instru- nt. We therefore do not see ctronic trumpets, trombones and on, because there is no means, with a guitar, of applying a k-up to the instruments concern- .

MPLE TO ADAPT

But in the case of a piano, with vibrating strings or an Ameri- n organ, harmonium, mouth gan, concertina or piano accordion ith their vibrating reeds, it is ite a simple matter to arrange r either an electrostatic or elec- omagnetic pick up from the vibrat- g member, depending mainly on e nature of the metal concerned.

As far as generation from piano rings is concerned, two success- l commercial applications are the Storytone" and the "Electrochord", e latter being a particularly in- enious device, in which the har- onic content of the induced waves ay be varied over a fairly wide ange. Also, the attack and decay f the notes may be selected so hat, when depressing a key, the ound may come instantly, as with percussion instrument such as the narimba, xylophone or chrysoglott, r it may build up comparatively lowly, as with the average organ ipe.

We shall discuss this business of harmonic content", "attack" and decay" at a later stage.

Of all the methods of making lectronic music, the most attractive o the amateur is, without doubt, he "electrifying" of vibrating reeds.

The advantages of this system of using reeds—usually from an old "pedal organ"—are that such instru- ments are the easiest and cheapest to build, and that a true ensemble effect may be obtained, together with the ability to play chords.

VARIETY IN TONE

However, certain difficulties do arise, mainly concerned with the amateur's inability to derive much variety in tone from the reed. This is a job for a skilled worker with laboratory facilities behind him and not for the usual home constructor.

It can be said that the untaught builder is able to get results easily and has wonderful scope for im- provement. He can, even from a very ordinary bank of reeds, ob- tain beautiful and satisfying tones.

This, of course, has brought us on to the subject of organs, and it is on this track that the writer in- tends to stay.

A word of elaboration is called for on the word "organ", so that there shall be no misunderstand- ing.

When we talk of electronic organs we mean instruments capable of producing a sustained tone. In other words, whilst a playing Key is depressed, there is a continuous sound from the loudspeaker; when the Key is released the sound dies away.

With some electronic organs the resemblance to a pipe organ, as found in church, cinema or con- cert hall, ends at this point.

However, do not let there be any disillusionment on this score, for there are in produc- tion some types of electronic organ which it is virtually im- possible to differentiate from a true pipe organ.

One such is the Model B6 in- strument, produced by the Allen Organ Company of Macungie, Pennsylvania, USA. Whilst it has deceived the most expert pipe organists and builders, it is quite a costly instrument, extending in price to 15,000 dollars. Even at this price it is not the dearest on the market.

But it is not our intention to compare, so much as to state, the facts and, whilst the writer is an ardent pipe organ enthusiast he cannot be drawn on such points!

ELECTRONIC "ORGANS"

We have reached the stage of talking about sustained tones, and it is because of its ability to do this that the type of electronic device under discussion gets its label of "organ".

Now, there are two types of elec- tronic organs—one is monophonic or melodic, and the other poly- phonic or full chord organ.

In the monophonic or melodic type of electronic musical instru- ment it is not possible to play more than ONE NOTE at a time. By all means the keys may be de- pressed to obtain a chord, but all you will hear is one note, usually the highest, in the chord so fin- gered.

This may sound rather an un- satisfactory arrangement, but the fact that 400,000 such instruments have been sold shows that they have their uses.

TYPICAL INSTRUMENTS

Before World War II, we saw in this country the American Ham- mond Solovox, just such an instru- ment. Today it is more popular than ever, judging by its sales in the United States and other dollar areas. Great Britain, too, produces at least three well-known mono- phonic keyboard instruments, namely the Clavioline, Maestrovox and Univox.

What can these instruments do?

Firstly, they are designed to be fitted onto a piano or organ by clamping screws, or to rest just

Pipe organs owe their richness and quality to the large number and the vagaries of individual pipes. Electronic organs can simulate selected tones but generally lack the "weight" and "complexity" of sound created by many ranks of pipes speaking in unison.

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id. They have their own key-
rd, so that we have a piano with
econd manual. This second set
eys is only three octaves wide,
ut 25 notes, but the instrument
lf can cover four, five or six
aves by depressing a range
tch.

he idea of these devices is to
ulate various instruments and
can hear a remarkable imita-
of a violin, clarinet, saxophone
other instruments, once the
ying technique has been master-
This usually takes only a mat-
of hours.

harts are usually supplied with
list of instruments and another
of numbers or letters. The idea
that if you want to imitate a
mbone, then you press tablets
E and F and button number three
d there it is, for the playing.

FFERENT ATTACK

The "attack" and "decay" of the
te may also be varied. For in-
nce, if the player wants to imi-
e a percussion instrument such
a bell, then he must select "fast
ack" and "slow decay" so that
e sound comes instantly and
arply, as in striking a bell, and
en fades away over a period in
bell-like manner.

When imitating a flute, however
must have a much slower build
of tone and a much quicker fad-
g away, both build up and fade
way (once the playing key is re-
ased) taking, say, no more than
ne third of a second.

These instruments may be built
y the radio minded constructor,
ith a good degree of success and
re reasonably cheap to make—
out £25 at the most—if you can
nd a second-hand keyboard, which
ew is rather an expense.

They are also capable of other
ery beautiful tones, modulated at
ill by a tremulant or vibrato,
hich tones do not in themselves
esemble any particular orchestral
nstrument.

Furthermore, they are light and
ortable and cheap to run, contain-
ng no more than five or six valves.

Certainly they can add to the en-
oyment of piano playing for, when
tted to a piano, one can play, say,
he violin with the right hand and
lay a piano accompaniment with the
eft. Indeed, some of the more
ractised players, the electronic
eyboard being a "one finger" in-
trument, can play the piano with
oth hands at once, letting the
humb or finger of the right hand
each down to the second keyboard.

MUSICAL HARMONICS

In short, these single finger elec-
tronic "organs"—definitely the
wrong name for them—have a con-
siderable attraction and are a simple
proposition for the radio hobbyist

It is at this stage that we should
discuss the very important matter
of harmonics: The word "harmonic"
might not be new to the reader but
a knowledge of harmonics, as en-
countered in electronic musical in-
struments, is absolutely essential to
the understanding of the theory of
their operation.

Let us start by asking a question.

One of the most ambitious electric guitars ever devised was this Australian developed "Kord King". It could be played like an ordinary guitar but depression of a series of foot pedals allow the tuning to be changed at will, making available up to 25 different chords on any one fret.

Supposing we sound the note middle A on a flute and have someone else sound the same note on a violin. The two instruments are in tune but what a difference there is in their tone! We can say that the tone color, or "timbre", is completely different and it is this difference in timbre which so distinguishes the one instrument from the other.

As a matter of fact it is the harmonic content of their respective tones which makes the difference. Now we come to our question: What is this harmonic content?

A harmonic may be described as any exact multiple of the pitch note. In this example, both instruments are sounding middle A, which is a vibration at a frequency of 440 cycles per second.

In the case of the flute there will be found, on analysis, a comparatively strong tone of 440 cycles per second; it will also be found that there is another tone present at exactly twice the frequency, that is 880 cycles per second. This second tone, while of lesser power than the main one (or fundamental) is at twice the frequency and is called the "second harmonic".

THIRD HARMONIC

Likewise, a third harmonic—which does tend to be present in the tone color of a flute—would be three times the basic or fundamental frequency; that is 1320 cycles per second.

The strength of the harmonics relative to the fundamental in a flute varies from instrument to instrument. Usually, however, with flute-like tones there will be found a comparatively strong fundamental, a fair amount of second harmonic and just the merest trace of a third harmonic.

Now, let us turn to the violin. What a difference there is in the harmonic structure of the note coming from its vibrating string!

True, its string is vibrating at a fundamenal frequency of 440 cycles per second but harmonic analysis shows that this frequency is of lesser strength than the higher harmonics and that the second harmonic is stronger than the basic tone!

In fact the third harmonic (1320 cps) the fourth harmonic (1760 cps) the fifth harmonic (2200 cps) the sixth harmonic (2640 cps) and the eighth (3520 cps) will all be found to be present, and mostly in greater strength than the fundamental.

And don't think that the harmonic content of a violin string ends there, because it doesn't. It is possible to find harmonics up to the thirtieth in many instruments, including the violin.

It is the presence or absence of these harmonics in their varying strengths which not only differentiates one violin from another, but also one musical instrument from another.

A tone which contains no harmonics is called a sine wave. The note middle A (440 cps), devoid of any harmonics, would sound dull. So, in fact, does any other pure tone.

TONE SYNTHESIS

Suppose that we have an audio tone generator giving us such a sine wave of 440 cps and we connect it through an audio amplifier to a loudspeaker. If the amplifier is not likely to impart any harmonics of its own making to the note, the tone coming from the speaker would

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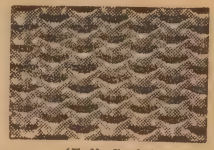

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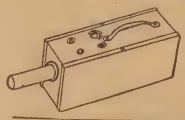

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dull and lifeless. Just a tone of
) cps—nothing more!
Now connect another audio gener-
or, giving a sine wave of 880 cps
the amplifier at the same time. If
e output of the second generator
of, say, half the voltage of the
st one you will hear coming from
e speaker a pretty fair resemblance
a flute! In the parlance of the
ectronic musical instrument engi-
er, we have "synthesised" flute
ne.
If we add just a small amount of
1320-cycle sine wave (the third
rmonic) from another audio
nerator, the effect would be even
re striking.
Similarly, it is possible to carry
t the synthesis of any other
usical instrument, provided we
ow the harmonic structure of its
rticular tone.
The flute, as we have said, is char-
terised by a fundamental, plus a
cond harmonic of equal or usually
sser strength, and perhaps just a
ace of third harmonic.

PPER REGISTER

The violin, in common with all
tringy" tones, is analysed as having
strong upper harmonic develop-
ent while the fundamental and
cond harmonic may each be rela-
vely weak.
A third kind of tone, commonly
et with in organs, is the reed,
aking its name from its orchestral
ounterpart. Reed tones imply the
resence of a number of harmonics,
ith emphasis on the first five or
x.
For example, take the clarinet
ne. Its second harmonic would
e about one third the voltage of
ie fundamental, the third harmonic
ould be of the same strength as
ie fundamental, the fourth would
e the same strength as the second,
ie fifth harmonic would be a little
ver half the fundamental and the
ixth of the same amount as the
econd and fourth.
Earlier in this section, it may have
een noticed that the seventh har-
nonic was not accorded a place in
ie violin's tone color. This is be-
ause it can be a particularly un-
leasant tone and is not always
resent in the harmonic development
f a musical sound.
The seventh does occur in a piano
tring but, so discordant is it, that
he piano builder usually arranges
or the hammer to hit the strings
n the place where the seventh har-
nonic would develop. Do not think,
owever, that this harmonic has no
se. It is this portion of the har-
nonic content of the harmonium
eed for instance, which gives to
he harmonium its peculiar "sweet
arshness" and, in organ tone syn-
hesis, it is essential for imparting
he characteristic "bite" to reed
ones, discordant as it may be in
ertain applications.

THE DIAPASON

It might be as well, just here, to
omplete our "family of tones".
Already we have described a typical
example of flute, string and reed;
ut there is a fourth, the diapason.
The diapason is not a musical in-
strument in itself but it will be
found that all organs have at least
one rank of diapason pipes, since
they constitute the foundation tone
of the pipe organ. Somewhat flute-
like, the diapason is characterised
by a strong fundamental and second
harmonic, with relatively and pro-
gressively weaker upper harmonics.
A typical diapason pattern, as far
as harmonic development is con-
cerned, is the following proportion
of relative strengths:
Fundamental and second har-
monics—equal.
Third and fourth harmonics—each
two-thirds of the fundamental.
Fifth and sixth harmonics—each
one-sixth of the fundamental.
If the reader is interested in
building an electronic organ, he
would be well advised to get to know
the different organ "voices" by
having a demonstration from his
local church or theatre organist.
String and reed tones are easily
picked by their obvious tonal quali-
ties but flutes and diapasons often
intrude into each other's domains
and it is hard to decide when a flute
is not a flute and so on.

TYPICAL NAMES

Another point, which can well be
raised at this stage, is the matter of
scaling. This is a term used in pipe
organ parlance, and means the
levelling or equalising of the volume
of a given rank of pipes, so that
adjacent pipes of the same type
sound at the same volume.
Quite often one comes across two
ranks of pipes which look and sound
the same, except that one rank
sounds or "speaks" at a noticeably
lesser volume than the other. We
then say that this rank has been
scaled down, in relation to the other.
In such cases the rank which has
been scaled down will be found to
have a different name to that of its
twin and, where one might be called
a "flute" stop, the other may be
labelled, for instance, "dulciana".
Before leaving this business of
harmonic content, it is most neces-
sary to learn that it is not only the
harmonics which make an instru-
ment so distinctive. There is a little
something besides, and this concerns
"overtones" and "formants".
An "overtone" is some interval
which is non-mathematically re-
lated to the fundamental. It is
actually discordant but is most neces-
sary to impart a realism to elec-
tronically synthesised tones. Over-
tones are usually relatively weak.
The "formant" is the natural
resonant frequency of an instru-
ment. Most instruments will be
found to have a resonance some-
where in their range, being mainly
due to the materials of which they
are constructed.

FORMANTS

It was because of a lack of under-
standing of the principles of for-
mants that the earliest electronic
organ designs fell short of that "real-
ness" which is an integral part, to-
day, of the majority of instruments.
Formants in wind instruments —
trumpets, horns, trombones, oboes,
and organ pipes, in particular—are
brought about by the resonance of
the material of which the particular
instrument is made. This charac-
teristic shows itself as an increase
in loudness at a certain frequency
in the instrument's range, which is
quite unrelated to the harmonic
structure of its tones.
Furthermore, the formant band
tends to show up no matter what note
is being played—or broadly speaking
this is the case.
Since the formant appears as one

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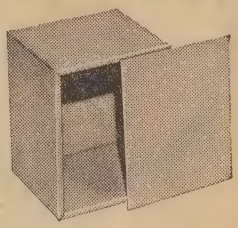

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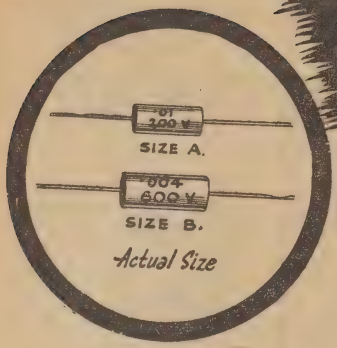

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.02 "	B	250 "	A
.03 "	B	300 "	A
.04 "	B	500 "	A
400 Volts D.C. Wkg.		.001 uF	A
.001 uF	A	.002 "	B
.002 "	A	.003 "	B
.003 "	A	.004 "	B
.005 "	B		
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150% of the working voltage for a period not exceeding 30 seconds at 15 — 20°C. Because of the self-healing feature a higher test voltage is neither desirable nor necessary.

CAPACITANCE TOLERANCE:

Standard — or + 20%; capacitances below 5 pf, — or + 1 pf. Closer tolerances of — or + 10% or — or + 5% are available for capacitances exceeding .0005 uF at additional cost.

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ed band of frequencies in its rela-
e instrument, irrespective of what
te in the range is being played,
follows that we should be able to
nerate a formant band separately
d add it to the other notes, thus
taining a fair resemblance of the
strument being synthesised.
The trombone has a formant
nging from 240-280 c.p.s. You
ll have seen the trombonist in
e local jazz band muting his in-
ument with a top hat or a mute.
e resultant tone (described in the
se of a B flat trumpet, by one
iter, as akin to the sound of a
mb and paper) is the strongly
centuated formant of the trom-
ne.
The French horn, with a formant
ound 400 c.p.s. and the oboe with a
arp formant band around the 900
cles mark, are further examples.
One of the jobs of the designer
an electronic organ is to see that
is formant band is provided in
e frequency spectrum of the in-
rument being synthesised. Pro-
ded this is done, that harmonics
e generated in their correct pro-
rtions and the "attack" and "de-
y" of the note is similar to that
the original—then we can say
at the major part of his design
complete.

IGH ORDER HARMONICS

In practice, many harmonics of
instrument being imitated may
e omitted and, in fact, little account
taken of those above the twelfth,
any rate where "additive syn-
esis" is employed.
Just a few minutes back, we men-
oned the injection of a sine wave,
an audio frequency, into an am-
lifier, and the addition of other
ne waves at frequencies constitut-
g the second and third harmonics
f the fundamental.
That is, we added other pure
aves to the original frequency and
nitated the tone of a flute. This
"additive synthesis" and is the
rinciple used by Mr. Laurens Ham-
ond in his famous Hammond
rgan and Hammond Spinet.
The alternative is "subtractive
nthesis", being the method of tone
rmation used nowadays by most
lectronic organ designers and
anufacturers.
In this system, a harmonically
ich waveform—a "square" wave or
sawtooth"—is generated, and un-
anted harmonics are extracted
choked or by-passed), leaving the
esired frequencies.
Many and varied are the methods
y which this subtractive synthesis
s carried out, and some of the ideas
mount to pure genius on the part
f the inventor.

MANY METHODS

At this stage the writer must
pologise if he appears to have been
umping from point to point, like a
utterfly from flower to flower.
However, there is so much to be
discussed and explained before de-
ailing the features of the various
commercial instruments, that it was
felt that a general ramble over the
ubject, touching on each point
s it came near, was the prefer-
able course.
Nor is this intended to be an ex-
haustive article on either theory or
practice. It is, as its name implies,
a survey of electronic musical in-
struments.

(To be continued)

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Band 4. 205 metres to 620 metres.

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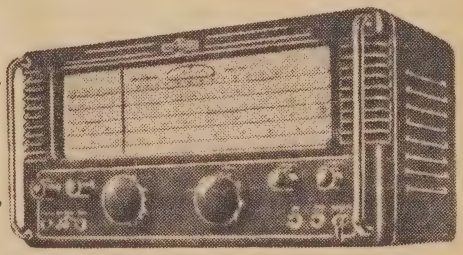

MODEL "750". Of double superhet type, this possesses very high selectivity with practically complete freedom from image interference. H.T. supply to the oscillators is stabilised.

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GETTING YOUR AMATEUR LICENCE

The use of directional aerials to increase the efficiency of radiation in a desired direction is commonplace today, and amateurs use such aerials for many purposes. This article discusses the fundamentals of directional aerials and describes some simple examples of them.

AN aerial which radiates power in many directions, and over wide arcs is a good thing for a broadcasting station where many people must listen at the same time, but it is not a very efficient device if we wish to communicate with a single station in a fixed location.

In such a case, only a small fraction of the transmitter's power is being used for our purpose. The remainder is wasted in heating up the ionosphere.

If we could succeed in concentrating radiation into a narrow beam aimed at the receiving aerial in the manner of a searchlight, very much stronger signals would be available for the receiver, and the effective power of the transmitter would be increased.

Strictly speaking all aerials are directional, because they all radiate better in some directions than in others. The simple dipole, for instance, is most efficient at right angles to its length, and radiates very poorly "off the ends".

SIMPLEST BEAM

But it does represent the simplest "beam" aerial, and it would work best if we could arrange to rotate it so that our communication point was always broadside, and never in line with the aerial itself. It is in fact not unusual to come across an amateur with a rotating dipole. Its characteristics are "discovered" by budding Marconis at regular intervals!

It is not particularly difficult to design directional aerials, and a prospective amateur is quite likely to be asked a question about them in his AOCP examination. It is well, therefore, to know something about the general principles of such aerials, and to be able to give the essential details and simple examples.

We have already seen that the ordinary dipole aerial has a characteristic set of radiation patterns, which can be illustrated by polar diagrams. These are simply diagrammatical representations of the radiation from it, indicating the directions in which it is strong and those in which it is weak.

By introducing other aerial elements into the immediate field of the aerial, it is possible to distort its polar diagram reinforcing it in some directions and reducing it in others.

These extra elements may be used in three different ways—

1. They may be excited by the transmitter by connection to the feed line to provide two aerial elements instead of one, the polar diagrams of which interact with each other to give the desired pattern.

2. They may be merely placed near the aerial, but not connected to the feed line, so that they operate as reflectors or directors, once again distorting the polar diagram to give the required pattern.

3. We may build an array consisting of several driven elements as well as reflectors and directors to give high concentration into a very narrow beam of radiation.

In actual fact there is a vast number of designs which can be worked out for such aerials. They are particularly suitable for VHF, where the element lengths are small enough to allow large numbers to be assembled in combinations which would be hopelessly unwieldy at lower frequencies. One has only to scan the advertisements of overseas magazines to see the endless procession of special arrays for which special performance is claimed.

For extremely high frequencies it is not unusual to see parabolic reflectors of the same designs as used for searchlights and radiators, and they are extremely efficient in producing radio beams only a few degrees in width. Physical size limits their use to frequencies measured in hundreds and thousands of megacycles.

Let us consider first of all the case of two identical driven elements parallel to each other, spaced one-half wave-length apart, and connected to the feedline so that the radiation from each is in phase.

"In phase," of course, means that the current and voltage distribution in each element is exactly the same at all times, and that the polarity is also the same at all times. An end-on diagram is shown in Fig. 1.

The fields radiated from each element, therefore, will be exactly the same in every particular.

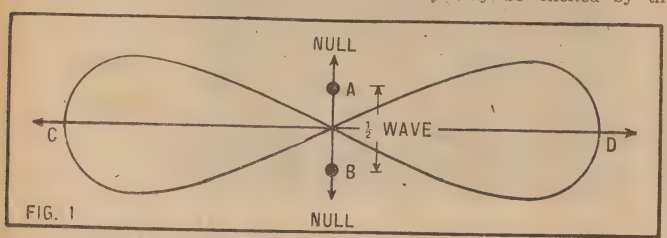

FIG. 1

Polar diagram of two half-waves spaced one half-wave apart and fed in phase.

HOW IT WORKS

Consider now the energy which is being radiated from element A toward element B.

On reaching B, it will have travelled one half-wave-length, by which time radiation from B will have changed in phase by 180 degrees, so that it is opposite to the phase of the radiation arriving from A.

There will be some attentuation due to its journey from A to B, but this will be very slight, and it will, therefore, almost completely cancel the radiation from element B.

Similarly the energy which is radiated from B will have met an opposite phase at element A, and cancellation will again take place.

As a result of this cancellation, there will be virtually no radiation along the line AB, and we will find a null point in both directions.

But, along the line CD, which is at right angles to AB, the radiation from the two elements will be in phase, and instead of cancellation we will get an addition.

What we have lost along AB we have gained along CD and the array is, therefore, bi-directional toward C and D.

Once again we should remember to visualise the radiation lobe as a solid shape and not a flat plane as our diagrams might indicate. In this case the two lobes are of the same shape and resemble a couple of "tear-drops" which have been squashed somewhat flat from above and below.

GOOD EXAMPLE

This is quite a practical type of aerial, and it illustrates quite simply the principle of addition and subtraction in radiated power through the interaction of the polar diagram of two radiators.

Note that the elements must be identical and must be exactly one half-wavelength apart for these results. If they are of different lengths, or if the spacing is not a half wavelength, the addition and subtraction of the patterns will not be so sim-

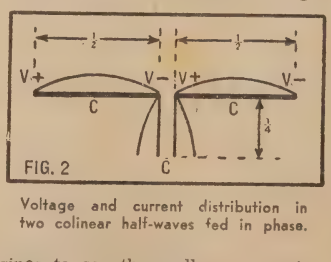

FIG. 2

Voltage and current distribution in two colinear half-waves fed in phase.

e, and we will obtain different re-
lts.

We will also radically change the
sulting pattern if the elements are
ot fed 180 degrees out of phase,

For instance, if the spacing is one-
uarter-wavelength and the phase
fference is purposely made only
degrees, by using different feed
ne lengths, a one-sided pattern will
e obtained. If we arrange to switch
e feed line lengths so that the 90-
egree lag changes from one element
the other, we can shoot the radia-
on either to the left or the right
the case may be.

The variations possible with two
ements alone are too numerous to
ention, and at this stage it is not
ecessary to describe them. The ex-
mples given here, however, should
e enough to illustrate quite clearly
ie principle of producing directional
atterns by using parallel driven ele-
ents, arranged to have the correct
hase relationships.

More than two elements may be
sed in an array of this kind for
xtra directivity.

Directional effects may also be ob-
ined by placing elements end to
id in the same plane to form a
o-linear array, and feeding them in
hase. The simplest example is
nown in Fig. 2, where we have two
alf-waves in phase.

ULL-WAVE AERIAL

An aerial which is one wave-
ength long is really two half-
aves connected together with each
alf out of phase because, as you
ill remember, a wave travelling
long a wire needs a full wavelength
or a complete rotation of voltage
nd current polarity. If we have
t a given instant a positive voltage
t one end, we will have a negative
oltage at the centre, which is the
nd of the first half-wave, and a
econd positive voltage at the far
nd of the aerial, which completes
he second half-wave.

The radiation pattern of such an
erial is shown in Fig. 3a. Because
he radiation from each half-wave is
ut of phase, there will be some
ancellation at right angles to the
wire, as well as the normal cancella-
ion off the ends, and the pattern will,
herefore, split into four equal lobes
pproximately at right angles to each
ther. If the aerial were several
wavelengths long, a whole series of
obes would appear with the centre
gap growing larger because of the
greater cancellation at right angles,
until most of the radiation would
concentrate off the ends of the aerial.

If we mount the two half-waves
as separate elements and feed them
in phase, the radiation pattern is
entirely different. Being in phase,
the radiation at right angles to
the elements will add, and we will
find a reinforced lobe in this plane.
The null point normally found
at the end of a half-wave will re-
main, but will be intensified be-
cause it is now the resultant of
two elements instead of one. Thus
we get the same general pattern
as from a half-wave dipole, but
with sharper lobes and a greater
concentration of energy in them.

PHASE REVERSAL

A simple and often used method
of feeding the elements in phase
is to connect a quarter-wave phase-
reversing stub to the inner ends as
shown in Fig. 2. It is in effect a

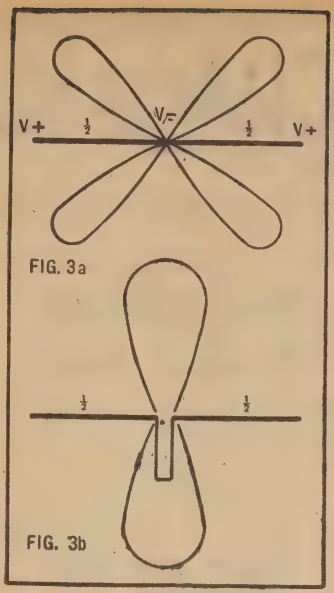

FIG. 3a

FIG. 3b

Fig. 3A shows the polar diagram of a full-wave aerial. Fig. 3B shows the polar diagram of two half-waves in phase.

third half-wave element folded on itself so that it becomes a length of feedline and will not radiate. As would be anticipated, there is a point of high current at the end of the quarter-wave, corresponding to the centre of the folded third half-wave, and the impedance at this point will be roughly 72 ohms. We could, therefore, attach a 72 ohm with a fairly good impedance feeder to the bottom of the stub match.

The diagram shows the voltage polarity which would exist along the elements assuming the aerial ends to be positive, and shows clearly that they are in fact in phase. The loops shown are current loops.

TWO HALF-WAVES

Extremely efficient aerial arrays are often constructed using this two half-waves in phase arrangement as a unit, stacking them one above the other in bays with the quarter-waves transposed so that each section is in phase with the one above. Such an array is a combination of the connections shown in Figs. 1 and 2, and results in an extremely sharp beam of high intensity.

Fig. 4 shows a 16 element array of two bays with the element polarities marked to indicate their phase relationships. Such an array is generally used with a reflecting curtain to give radiation in only one direction, with a further gain in power.

A parasitic array, sometimes called a Yagi after the Japanese scientist who developed it, consists of a single radiating dipole with additional elements spaced fore and aft to act as directors or reflectors. Being mounted in the same plane, these parasitic elements distort the dipole's pattern so that radiation is concentrated toward the directors and away from the reflectors in a beam, the sharpness of which will depend on the number of elements comprising it.

PARASITIC ARRAY

Fig. 5 shows a typical, parasitic array consisting of a radiator, a reflector, and a director, to form a beam which is perhaps the most popular in use today.

When the radiated field from an aerial strikes a metal object, currents are induced to flow in it and voltages are set up along it. If the metal object is a length of wire or rod approximately the same length as the aerial, these currents and voltages are quite appreciable,

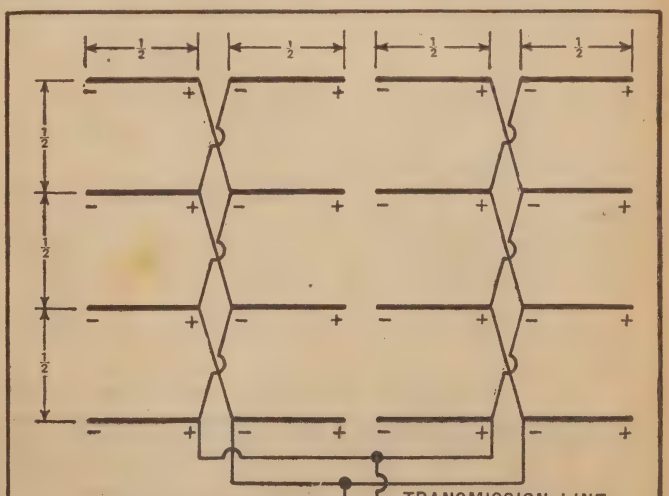

FIG. 4

A directional curtain array showing voltage distribution for 16 elements. Actually a combination of Figs. 1 and 2.

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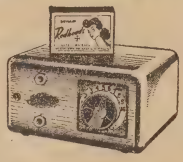

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(Continued from Page 7)

ıd the element will re-radiate most the power it has absorbed from e field of the aerial.

This radiation will be in phase out of phase with that of the rial depending on whether the ement is capacitively or inductive- reactive with respect to the rial. This in turn will depend on e length of the parasitic element, d its distance from the aerial.

For instance, if we have a di- ctor and a reflector spaced a uarter-wave from the aerial as in ig. 4, the reflector must be slight- longer than the aerial to be in- uctively reactive, and the director ıust be slightly shorter. In round gures, the discrepancy in each ase will be about 5 pc of aerial ngth.

)PERATION

Let us consider what happens in ıe array shown in Fig. 5. When ra- iation takes place from the aerial, s field extends and meets the reflec- or, inducing currents to flow in it nd radiation to take place which is pposite in polarity to the field from he aerial. These fields cancel, and nere is therefore virtually no radia- ion beyond the reflector. There is ome, because the energy radiated rom the director is never quite as reat as that from the aerial because f normal attenuation and losses in he reflector itself.

The distance between the aerial nd the reflector is one quarter-wave, vhich means that the reflected wave rrives back at the aerial after a ourney of one half wavelength dur- ng which time the radiation from he aerial has changed to the oppo- ite polarity. But because there has lso been a phase change at the re- lector, its radiated energy is now in hase with that leaving the aerial nd the two fields add together in the irection of the reflector.

A similar process takes place when he aerial radiation reaches the direc- or, but because it is shorter than the erial, its induced radiation is in hase with that of the aerial. The two ields add in a forward direction, but ancel in a rearward direction. The irector therefore assists the reflector n concentrating the radiation of the rray.

ARRAY TUNING

It is obvious that for efficient operation, the delay in time between the radiation leaving the aerial, strik- ing an element, and returning again to the aerial must equal that required to travel one half-wavelength. If the spacing is less than a quarter-wave, the extra delay time must be made up by increasing the mount by which the elements are reactive with re- spect to the aerial. Increasing the re- flector length increases its inductive reactance and causes a lag in the current flow with respect to the vol- tage.

If a director is closer than a quar- ter-wave, a similar electrical delay must be introduced by shortening it. This will increase its capacitive re- actance, and cause the voltage to lag the current.

Thus we can decide on various combinations of element spacing and length according to the exact amount of gain and the particular polar dia- gram we wish to produce.

The radiation resistance of the aerial will be changed by the addi- tion of parasitic elements because of the mutual coupling between them.

In multi-element arrays the calcu- lation of this resistance is extreme- ly complicated.

The addition of one element space one-quarter-wavelength from the aerial will reduce the centre im- pedance from 70 ohms to about 50 ohms, and the addition of a second element similarly spaced will cause a further reduction to about 30 ohms.

Closer spacing will bring the im- pedance to a very low figure, and

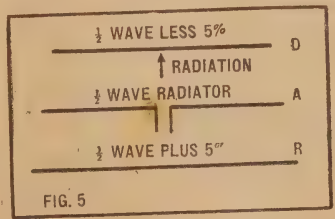


FIG. 5

General arrangement for a 3-element parasitic array known as a Yagi.

a 3-element array spaced .1 or .15 of a wavelength may exhibit a centre impedance of about 10 ohms or less.

The gain in a forward direction of a 3-element beam is about 8-9 db, which is quite appreciable. A 2-ele- ment beam would give a gain of about half this amount.

strong pulse from its own transmit- ter. This could upset the various delay circuits built into the equip- ment and the carefully-timed and spaced pulses which operate the sys- tem.

To avoid this effect, a difference between the two frequencies of at least 9 Mc must always be main- tained.

There are numerous circuit re- finements too complicated to be con- sidered here, for although the sys- tem is essentially simple, there are many technical problems involved in making the equipment accurate and automatic in operation.

For instance, at the beacon there is a small time delay required for the signal to be received, and the transmitter to be triggered to send out its reply. This time delay is not easily controllable, and would by its variable nature insert an error in the distance measurement which would change from time to time.

TIME DELAY

A fixed delay period is therefore built into the beacon circuits and allowed for in the aircraft receiver circuits, equal to 12.4 micro-seconds, or the time taken for radio waves to travel one nautical mile. This is large enough to take up the error and preserves the accuracy of meas- urement.

Because the same aerials are used for transmission and reception, elec- tronic switches are required to change connections from transmitters to receivers so that they operate in synchronism with the pulses being sent and received. All these things add to the complexity and general design of the equipment, but have been successfully overcome.

In the aircraft, the complete unit is built into a single box complete with its own motor-generator power supply operated from the 28 volt DC supply of the aircraft, and draws a current of 8.2 amps.

The Interrogator-Responder, as it is called, is built on the unit principle, with each main section complete on a sub-assembly for easy removal and service.

TRANSMITTER

The transmitter consists of a push- pull oscillator with the main tuning in the grid circuit and it has a peak output of 400 watts. This high peak power from small valves is possible because they are not operating con- tinuously but in a series of short pulses. The plate dissipation when averaged out over a period is there- fore comparatively small, and high voltages are used to build up the power radiated for the extremely short intervals of time.

The receiver, which has an inter- mediate frequency of 30 megacycles, has a specially shaped bandwidth wide enough for reception of the steep pulse wave-form, and is highly sensitive. It includes circuits making it insensitive to pulses longer than those received from the beacon, and these help to render it insensitive to random noises which might inter- fere with operation.

The ground beacon installation is housed in two racks. Each has a complete spare equipment arranged to come into action at a few minutes notice if the other should fail. This is accomplished by a special monitor- ing equipment which keeps an elec- tronic check on operation.

In general principles the instal- lation is similar to that of the air- craft, but is much larger and in- cludes its special facilities for pulsing and coding.

The transmitter, again controlled by lecher lines, uses a push-pull oscillator with controlled frequency and a peak power of 4 Kw.

CODING SIGNAL

The Morse Code signal which identifies the beacon is originated by a small disc with the appropriate symbols cut around its periphery and driven by a small motor. The discs are interchangeable. The char- acters are transmitted at approxi- mately six words per minute.

Naturally a design of this kind has many components, but these, in- cluding the valves, are manufactured and selected for their high stability. The aircraft equipment, for instance, has 44 valves, germanium diodes and neon lamps but only eight different types are included in this number to reduce the variety which must be kept in stock.

The standard fitment of DME to our commercial aircraft is a big step forward in the general pattern of the safety program, and its oper- ation compares more than favor- ably with any similar type used anywhere in the world.

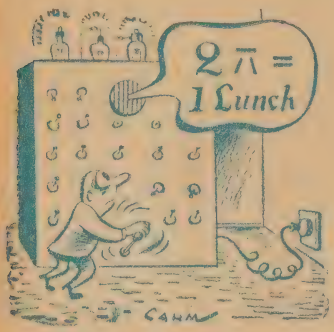
Here's your answer, Tom!

It is true, that the word Hobby appears in the name of this magazine. But then, very few of us consider gardening as a hobby. For the majority it conjures up visions of hoes, spades, lawnmowers and —aching backs.

THAT was the reason why we eyed Tom's first question with some suspicion.

What is the best type of earth? And why is the earth necessary?

Depends on what you want to grow, Tom. For paspalum, heavy clay with a sprinkling of housebricks or shale is the best. However, there does not seem to be any such easy recipe for growing the perfect lawn. As for gar-



. . . crackles out the answer.

den plants, well, nearly every kind seems to like a different type of earth. You have to be a horticultural expert to know them all!

It would be wise to add at this juncture, that radios do not require a specially prepared soil to grow in, and certainly no watering for proper development, as an overseas magazine seemed to suggest some time ago.

We have a faint inkling, however, that Tom really wants to know the best type of earth to use for radio receivers and other electrical apparatus.

IN TWO PARTS

We will answer the second part of your question first, Tom, because it is the more important one.

In electrical theory we consider the body of the earth as being at zero potential. This establishes a convenient reference point and we normally refer to other potentials as being so many volts above or below earth potential.

In big generating plants, the frames of generators and possibly one of their terminals are earthed. This is done to prevent electrostatic charges from accumulating on the machines and to prevent interference from sparking brushes entering the distribution lines.

Usually there are a number of transformers in the line before the generated current reaches the power point in your home, Tom, and these are earthed in a similar manner.

Thus, a potential difference exists between the unearthed side of the supply and earth.

If there happens to be a breakdown between the active (unearthed) side of the mains and the frame of an electrical appliance connected to the mains, the frame would obviously be at a potential 240 volts above that of the earth.

Touch that appliance, Tom, while standing on the wet laundry floor (which would most likely be at zero or earth potential), and the heading of this page would in all probability read, "Here is your answer, Dick! (or Harry)." You would complete the circuit to earth, with most undesirable results.

SAFETY MEASURE

That is why electricity supply companies insist that the frame of every appliance should be earthed. In case of a breakdown there would be a short circuit, the fuse in the active side of the mains would blow out, cutting off the dangerous potential.

Blown fuses are so much easier to replace than blown Toms!

Earthing in a radio receiver assumes only a secondary importance as a safety measure, because most sets are enclosed in a wooden or plastic cabinet. Metal parts which may become alive due to a breakdown, are usually covered by the cabinet sufficiently to prevent probing fingers from touching them.

But there is another reason, why radio sets should be earthed, and this has to do with the way the radio aerial works.

You see, Tom, we can consider the aerial wire as one plate of a capacitor, the other plate being the surface of the earth. Within the set there is the aerial coil, with one end connected to the aerial and the other to the chassis.

If the chassis is earthed, this arrangement reveals itself as a capacitor and inductor connected together, serving to pick up the signal and transfer it to the receiver's input circuit.

You have every right to ask how a radio will work without an earth?

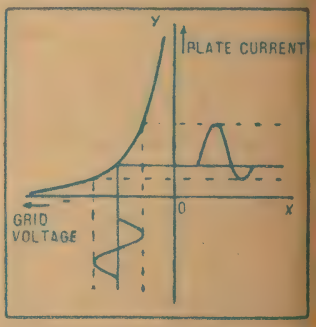
We have read previously that one side of the mains is usually earthed. Now there is enough capacitance between the primary of the mains transformer and the chassis to allow the passage of radio frequency currents. This means, that so far as RF is concerned, the chassis is really at earth potential.

But there is a "nigger in the woodpile". There may be enough impedance in the mains wiring between the set and the actual point of earthing to prejudice the performance in some cases. Where this happens, the correct procedure is to earth the receiver directly by a lead having the least possible impedance and resistance.

TYPE OF EARTH

We have now reached the first part of the question. The best type of earthing is one which has these characteristics. It may take the form of a pipe driven into the ground or a copper plate buried deeply. The type of soil doesn't matter much, as long as it is reasonably moist to give a low resistance contact.

Where appreciable amounts of RF power are involved, as is the case with transmitting aerials, the earthing may take the form of miles and miles of copper cable and meshing buried at ground water level



How detection occurs in an amplifier stage.

to provide the necessary low impedance path to earth.

In his next question, Tom leaves the earth and rises to somewhat higher levels. To be exact, he has spotted the fluorescent light on the ceiling and would like to know something about it. Here it is:

I have noticed that circuits for fluorescent lights specify a choke for use with certain types of tubes. What is this choke for? Can you make one yourself? If so, could you give me the formula for it?

Easy does it, Tom, one at a time!

)r do you think we have one of hose electronic brains at our office, vhich handles three problems at nce and crackles out the answer n five seconds?

The fluorescent tube contains rarefied mercury vapor. Before the ube can emit light, it is necessary o ionise this vapor or gas. This s done by heating the filaments n each end of the tube, which hen bombard the mercury atoms vith electrons, giving them an elec- ric charge. In other words the lectrons "ionise" the gas.

Once the gas is ionised, the fila- nents are extinguished by a small utomatic switch called the starter. The gas remains in its conductive tate as long as the voltage is main- ained between the ends of the ube.

MUST LIMIT CURRENT

In fact, the tube resistance be- omes so low that it becomes neces- ary to limit the current through t to a safe value. Were this ot done, the light would simply blow all the fuses in the circuit, nd, at the same time, probably lestroy itself.

This would be a highly unsatis- factory state of affairs, so some de- vice had to be found to limit the current to a safe value.

This could be (and indeed is) done by introducing some external resistance into the tube circuit. The only trouble is, that this resistance consumes a considerable amount of power which is wasted in the form of heat.

In some fluorescent fittings this resistance takes the form of an in- candescent lamp connected in series with the tube. Although this ar- rangement does convert some of the wasted power into light, it is still not an altogether economical one. It is a far cry from a truly "cold" light.

However, power is mostly sup- plied to consumers in the form of AC and there is a device, which will limit the current on AC, with- out consuming power itself.

This device is a choke, common- ly known in fluorescent applications as the "ballast".

SIMILAR DEVICES

There is no fundamental differ- ence between a fluorescent and a radio type choke. Both work ac- cording to the same electrical laws, although differing in detail, due to their different application.

For example, fluorescent chokes do not normally have an air gap in the iron core, because they are not required to carry DC. Also they normally have a higher current rat- ing, in order to cope with higher currents than are usual in the aver- age radio receiver.

Due to the high current and con- sequently strong magnetic field in them fluorescent chokes have to be assembled very rigidly, and rubber mounted or "potted" to prevent lamination hum.

If a voltage is applied across the terminals of a choke, current begins to flow and a magnetic field starts to build up in the core. This build- up of the magnetic field does not allow the current to reach its maxi- mum value until some time after the application of the voltage.

Reversing the polarity of the volt- age causes the magnetic field to collapse inducing a current of the same direction as the original cur- rent. This current will now op- pose the one due to the reversed voltage, thus delaying and impede- ing the current flow through the cir- cuit as a whole.

In the case of 50 cycle AC, the polarity of the voltage is reversed fifty times per second. The cur- rent through the choke also reverses the same number of times, but lags behind the voltage. In an ideal choke the time lag would be one two-hundredth of a second. In elec- trical language one would say that the current would lag behind the voltage by 90 degrees.

We can thus imagine that the power is used to build up the mag- netic field in the choke, during part of the cycle. When the field col- lapses due to the diminishing volt- age, this power is again released into the circuit. This is repeated twice during each cycle.

Although effectively limiting the current, it does not consume power itself.

In practical applications the choke does use some power, due to ohmic resistance of the windings and losses in the core material, but these losses are comparatively small.

Only the tube consumes appreci- able power, but, due to its effi- ciency in converting electrical energy into light, the light output from it for a given amount of power is much higher than from an in- candescent lamp having the same consumption.

In an incandescent lamp, a large proportion of the power is turned into heat instead of useful light output.

If you know the actual tube cur- rent, Tom, you can work out the size of the choke from formulas found in advanced textbooks. The trouble is that this most impor- tant information is not usually avail- able.

TRIAL AND ERROR

Even design engineers have to work out the values from approxi- mate data first and determine the finer details by experiment.

This latter part of the job calls for a generous helping of maths, which is not likely to be available to you, Tom. Of course, if you have the necessary specifications for wire size, number of turns, size and shape of the iron core and the kind of iron to use, there is nothing to stop you from making a choke for a fluorescent light.

But then it would be so much simpler to go and buy one. Fur- thermore, we have a faint suspicion, that it would be cheaper, too.

Having got this far we shall now

(Continued on Page 113)

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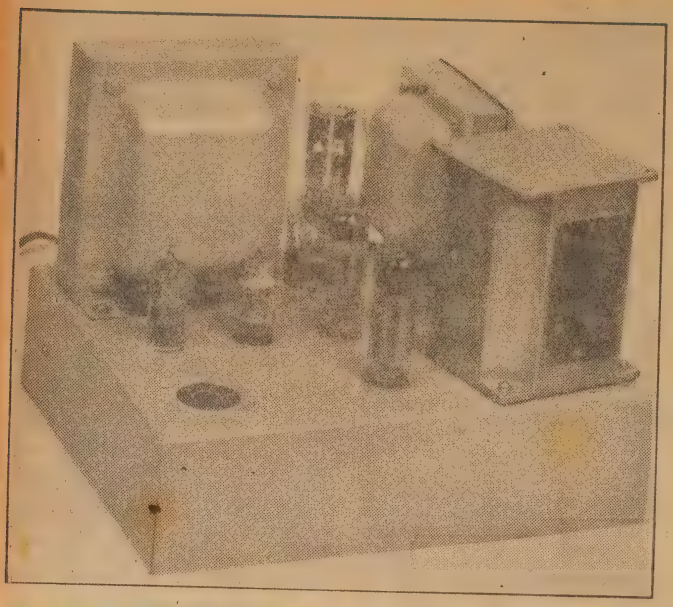


The amplifier looks very much like Playmaster No. 7 and uses the same chassis. The socket in the foreground is for connection to the control unit. The output valves are the new EL84's.

ULTRA-LINEAR PLAYMASTERS

These two new Playmasters can be regarded as the best over-all performers so far described. They give you the choice of high or medium output power but otherwise their general quality is about the same. Used with any of the Control units previously described, they will give you superlative sound.

by John Moyle

THE Ultra-linear or partial triode circuit has created more reader interest than anything we have discussed for quite a long time.

Undoubtedly this is due largely to the growing popularity of good quality amplifiers, although goodness knows there have always been plenty of amplifier enthusiasts.

But this circuit holds a particular fascination through its sheer simplicity. Merely by adding two wires to a tap on the output transformer, a whole series of possibilities have been created, the end of which may not yet be in sight.

SOMETHING FOR NOTHING

There is even an air of something-for-nothing about it, and who isn't intrigued by this possibility? For out of the discussions and experiments and general talk which has appeared during the last few months, it is hard to deny that this suspiciously simple circuit is nearer to resolving the triode-pentode controversy than any other which has come our way.

And yet, as so often happens, it isn't something which has burst like a bomb. The Ultra-linear circuit has been in existence for years, but until recently the world at large just hasn't woken up to how good it is.

To be perfectly honest, it is over four years since one of our keen readers drew our attention to an article in an overseas magazine which gave a good deal of information about it, including an amplifier circuit and performance curves which should have made any sensible person prick up his ears.

But no—like so many others we made a mental note of it, wondered just how much of it could be substantiated (age and suspicion having soured our nature)—and went on our way. We did consider the circuit interesting enough to reprint at the time, but did no practical work with it.

Today, having built four or five amplifiers of this type, and checked the results from many transformers, we are somewhat rueful that we hadn't the sense to do it all long ago.

However, there it is—maybe we have made up for lost time. We are in good company, because the regularity with which it is seen now in American and European designs leads us to think that many others have also thought it worth while to run a couple of tranformer taps, make two connections and produce better amplifiers.

HOW MUCH BETTER?

Are they better, really better? Can we tell the difference?

I think they are better, definitely better than comparable pentode amplifiers, and virtually equal to straight triodes. If we take the matter of efficiency into consideration, there isn't any doubt.

Judged on the basis of absolute amplifier performance, I think the difference may be lost in the variations which exist between individual amplifiers, valves, and particularly different output transformers. Maybe that's the same thing as saying that the difference isn't worth talking about, and, as applied to amplifiers intended for musical reproduction, that may well be the truth.

A typical comparison, for instance, might be between the Playmaster No. 5 which used push-pull 2A3's, and the amplifier described a couple of months ago using EL37's.

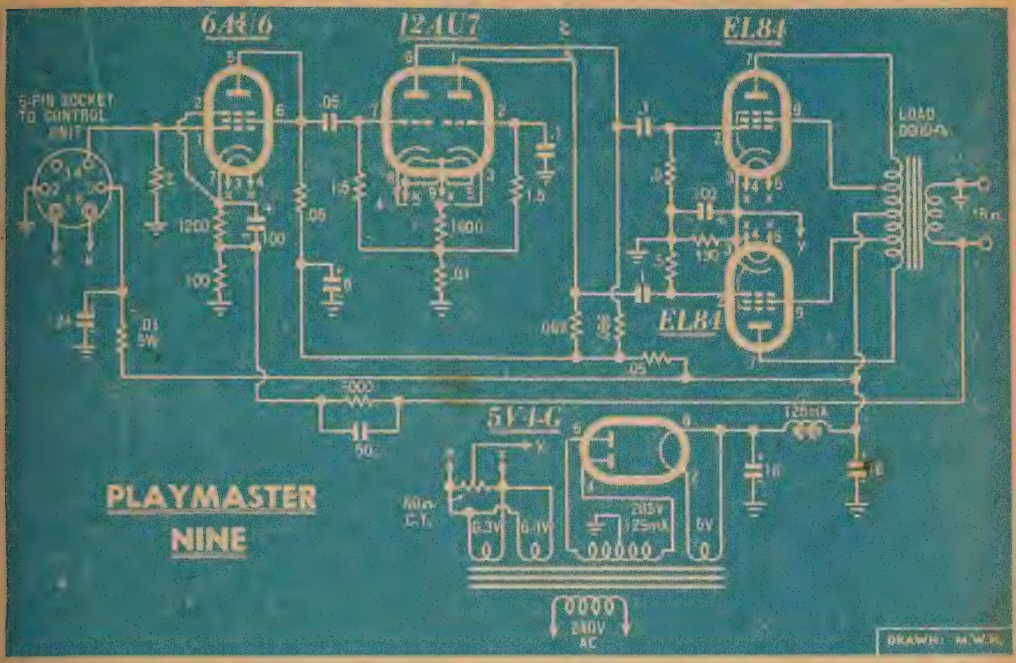
TEST COMPARISON

Just for curiosity's sake, we recently ran some frequency, power output, square wave and output impedance tests on them both, although it was not possible to include straight distortion measurements. However, as the amplifiers had previously been checked and found extremely good in this regard, for the moment we left it at that.

Frankly there was very little to choose between them. In frequency response, it wasn't worth worrying about any discrepancies up to about 100 Kc, and a small rise near this point in the 2A3 amplifier was probably due to differences in the output transformers which were of different makes. It is doubtful whether the point is even worth mentioning.

On square waves the EL37's showed less ringing at 5 and 10 Kc

CIRCUIT OF THE EL84 ULTRA-LINEAR AMPLIFIER



The circuit of the new amplifier is very similiar to that for the EL37's on page 63. The 285-volt transformer will not give quite 300 volts required for full output, but there will still be about as much as from the No. 2 Playmaster. At the moment transformers rated at 300 volts per secondary side are not standard lines.

than the 2A3's, but both were so much better than the EL37's as pentodes that they must be regarded as almost equally good, and again the transformer must be taken into account.

As far as variation in output voltage with changing load impedance was concerned there was so little in it that the two really couldn't be separated.

I am quite sure that on a listening test it would be impossible to identify these two, or to detect any differences one from the other. Certainly considering the time it took to change them over in an amplifier set-up otherwise the same, I'm sure no one could have picked which was which.

BETTER THAN PENTODES

On the other hand, I believe that it is possible to appreciate the difference when using a straight pentode amplifier of comparable quality, and I think the extra clarity is due to better transient response as demonstrated on best quality records, pick-ups, and speakers. I suspect very strongly that the square wave tests are most significant on this point, although it is probably only of full importance if the amplifiers are coupled to the best auxiliaries obtainable at the moment.

Maybe those readers who built the 2A3 Playmaster, and wrote to us in such glowing terms weren't kidding. It could be, too, that our pickups, speakers and records have improved so much in a few years that they no longer mask the faults we knew were there in our equipment itself.

It is natural, therefore, that we should consider the application of Ultra-linear to the Playmaster amplifiers, as a means of making a good series better with little or no extra cost.

Some readers have been a little puzzled that the EL37 amplifier wasn't named a Playmaster straight away, but there was a reason. The Playmasters have proved so reliable and have been so widely accepted that we wanted to build up as clear a picture as possible about the circuit before doing so.

As a matter of fact, the thing has been done whether we intended it or not, as that amplifier is now considered a Playmaster by its users just as firmly as any other.

And because I have used it and tested it sufficiently to adopt it as my own listening medium, we may as well give it our full blessing, which we hereby do!

More than this, we have built up a second version using the EL84 output valves, which are now available, and for which many have been waiting.

Ths valve provides better output than the 6V6, which is comparable with it in power requirements and cost, and allows the Playmaster No. 2—probably the most popular of them all—to be improved upon without prejudicing any of the things which built that popularity.

The circuit is, in fact, precisely the same as that used for the EL37's.

PARTS LIST

1 Chassis as used for No. 7 Playmaster.

1 Power transformer 285/285v, 120 mA secondary standard type.

1 Filter choke 10-20 Henries 120 mA.

1 Output transformer 8000 ohms plate to plate load to suit speaker with tap for Ultra-linear connection.

Valves 2 EL84, 1 12AU7, 1 6AQ6, 1 5V4G.

Electrolytics 2 16 mfd 600v, 1 24 mfd 350v, 1 8 mfd 350v or higher, 2 100 mfd 40v.

Paper condensers all 400v or higher—3 .1 mfds, 1 .05 mfds.
1 50pf mica condenser.

Resistors ½ watt—2 1.5 megs, 1 2 megs, 2 .5 megs, 1 68K, 1 56K, 2 50K, 1 10K, 1 5K, 2 1K, 1 1.2K, 1 100 ohms
1 10K 5-watt resistor.
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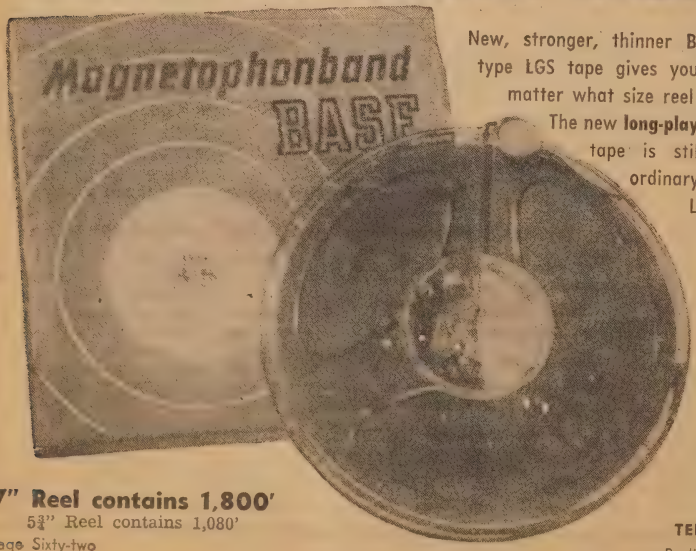

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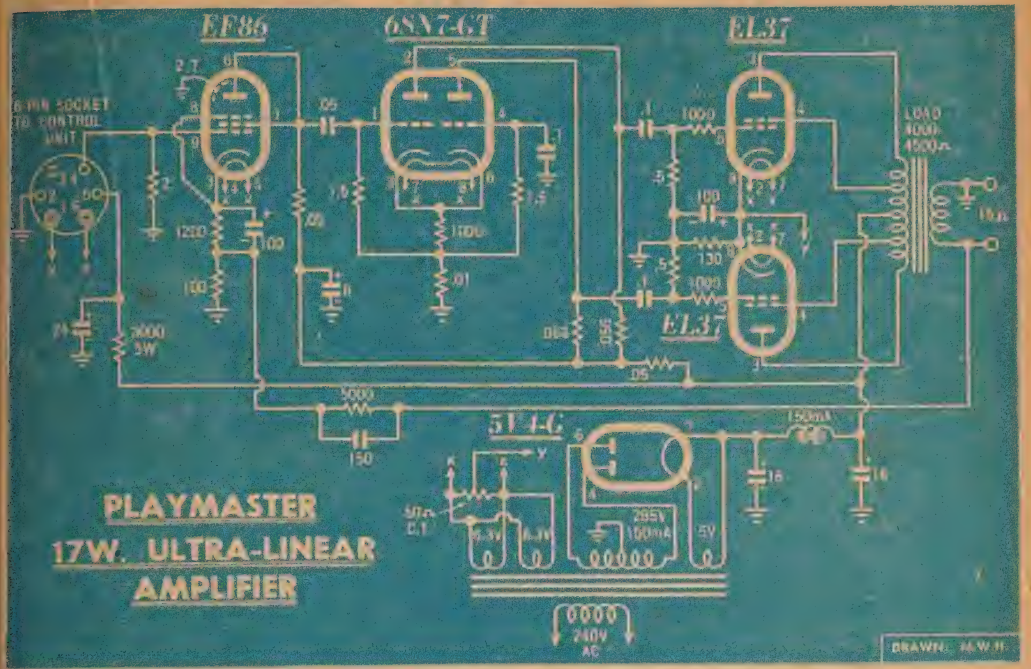
CIRCUIT OF THE EL37 ULTRA-LINEAR AMPLIFIER



Here is the circuit of the EL37 amplifier described in detail a few months ago. It can handle more power and has very slightly better characteristics than the smaller job. Note that it uses a larger chassis—actually the same as that specified for the Playmasters Nos. 1 and 2.

The main difference is that the latter will give a higher output than the EL84's, and it is possible that the transformers made for it are slightly better in quality. Frequency response is fractionally better, and the power curve particularly at the low frequency end is more even. The smaller job certainly won't give 14 watts or more of clean output at 20 cycles, but it should produce 7 or 8, and that is quite a lot in a region which is rarely used.

POWER OUTPUT

The exact output figure will depend on how the applied voltage works out, but with a rating of 17 watts into the primary as pentodes, you should achieve about 12 watts in your ultra-linear version, and we have measured more than this into a resistive load at 1 Kc.

Frequency response is extremely good, being quite flat between 50 cycles and 60 Kc. At 20 cycles our amplifier was 1 db down and at 80 Kc it was .5 db down. We have measured response as high as 300 Kc with a variation of only a db or so up and down on the way, after which, as might be expected, the output fell away. Some of our tests were actually made with an RF signal generator as normally used for work on radio receivers!

It is, I think, reasonable to assume that such an amplifier is much more than adequate for reproducing a band between 20 and 15 Kc.

On square wave tests, the amplifier gave a result very little inferior to the EL37 version. Even at 10 Kc the flat top showed no more than a few shallow ripples and virtually no overshoot, while at 5 Kc and 1 Kc it was difficult to detect any change in the shape of the wave-form fed to it.

The main loop provides about 16 db of negative feedback and this should be adequate for all purposes. More than this is not really recommended, as previous tests show clearly that, unless transformers of superlative quality — and cost! — are used, any tendency to grow peaks in the super-sonic region are accentuated by using too much feedback, and that in the past many amplifiers have in fact been spoiled rather than improved by "piling it on".

Strictly speaking, we should use transformers so good that feedback is not necessary to improve their performance, its main virtue being to provide a low output impedence.

But not being millionaires or research students, we must pay attention to equipment cost, and are suitably grateful that feedback can make a good transformer behave even better. But the fact that it isn't perfect means that sooner or later we can run into instability and poor transient response unless we know when to stop. This point of view has been amply demonstrated by the numerous tests we have made re-

PARTS LIST

1 Chassis as used for No. 1 Playmaster.

1 Power transformer 285/285v, 150 mA secondary standard type.

1 Filter choke 10-20 Henries 150 mA.

1 Output transformer 4500 ohms plate to plate load to suit speaker with tap for ultra-linear connection.

Valves 2 EL37, 1 6SN7, 1 EF86, 1 5V4G.

Electrolytics 2 16 mfd 600v, 1 24 mfd 350v, 1 8 mfd 350v or higher, 2 100 mfd 40v.

Paper condensers all 400v or higher— 3 .1 mfds, 1 .05 mfds.

1 150pf mica condenser.

Resistors ½ watt—2 1.5 megs, 1 2 megs, 2 .5 megs, 1 68K, 1 56K, 2 50K, 1 10K, 1 5K, 2 1K, 1 1.2K, 1 100 ohms 1 3K 5-watt resistor.

1 130 ohms 3-watt resistor.

Terminal strip, tag strips, nuts and bolts, power flex, solder lugs, etc.

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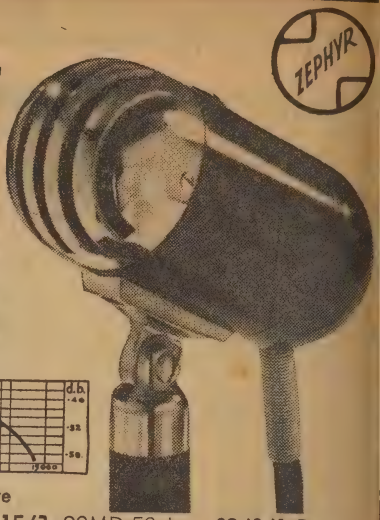

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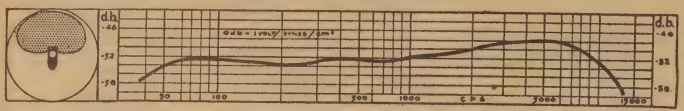

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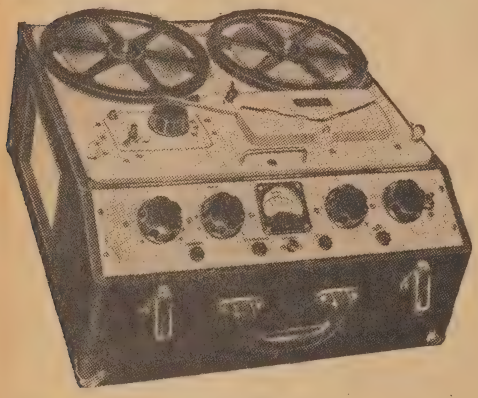

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ntly with the kind of transformers u can buy and the circuits which ll be used with them.

It should be remembered, too at the main loop is not the only urce of feedback in the amplifier, you accept the view that the Ultra-near circuit provides internal feed-ck around the output stage itself. r. Williams has had a grand old gument about this, and I'm not ing to steal his thunder. But con-entially I am quite happy to con-der that feedback to be there, and oreover I suggest it is equal to out 6 db in addition to anything u like to add overall.

ISTORTION

We have made frequency and termodulation distortion measure-ents with this amplifier in various ages of its development, and are ite satisfied that up to overload int neither exceeds 1 pc, and in e working region of 3 or 4 watts negligible. When dealing with dis-rtions of this order, it is rather intless to be too dogmatic, as small riations are almost certain to cur with different output trans-rmers and valves, even of the me make.

Both circuits use a triode-con-ected pentode in the first stage, llowed by a cathode-coupled phase-anger or standard type. Some de-iled comment on these points was ntained in the original article on e EL37 amplifier.

The new job uses a 6AU6 instead an EF86 as much for demon-ration purposes as anything else. anything we prefer the EF86 but ere is little to it and the circuit alues are exactly the same. Many ave asked whether the 6AU6 could e used, so we used it just to illus-ate the point. There is a slight ifference in gain between them, ut not enough to be important.

It also uses a 12AU7 as the phase-anger instead of the 6SN7. These alves are similar electrically, and gain the same values can be used. Ve suggest you include whichever alve is most convenient, and only ne sockets will need to be changed.

The EL84 is a very efficient valve vith a Gm of over 11 mA/V and equires a grid bias of 8-10 volts or class AB. It is therefore more ensitive than the EL37, and the nput required for full output is a ittle less — about 200 — 250 mV ccording to the exact plate voltage nd degree of feedback.

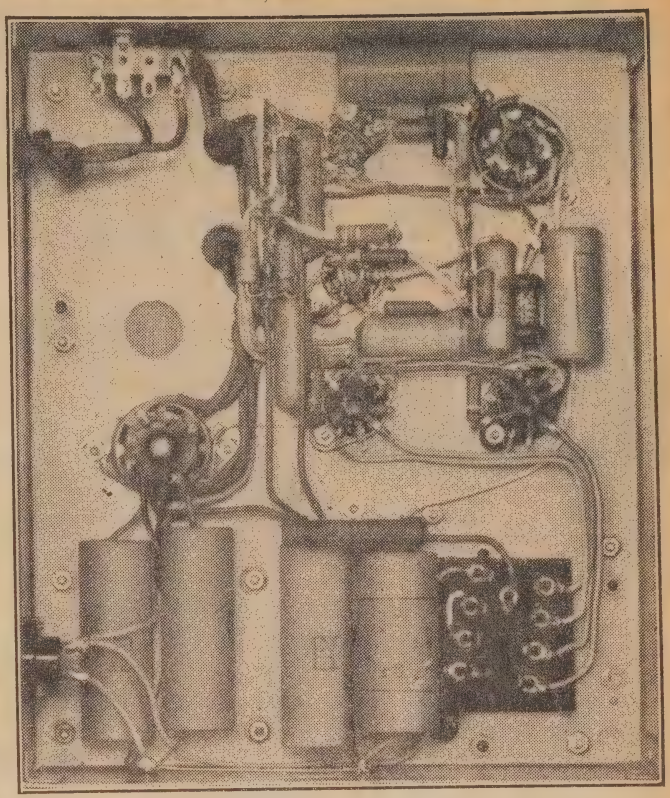
CONTROL UNITS

This is just about ideal for con-nection to the Playmaster Control nits, any of which can be used with it, The same is true of the arious tuners including the new FM tuner.

For best results in Ultra-linear we should try to operate the valve at the maximum plate voltage of 300 measured between the plate and cathode. This voltage should be approximated by using a standard 285 volt power transformer rated at 120 mills if a tuner is used, or 100 mills if not, and a 5V4 rectifier. This should ensure an output of at least 12 watts from the secondary. Lower voltage will reduce the output but will not otherwise upset the circuit.

Typical circuits for the EL84 in-variably show 1000 ohm suppressor

UNDER CHASSIS LAYOUT IS SHOWN



This under-chassis view shows that the amplifier is not difficult to build. Reference to this picture is contained in the article.

resistors in the grid circuits and about 250 ohms in the screens. Neither is included in our circuit for the simple reason that at no time was there any suspicion of parasitic oscillations without them. We mention the matter purely for the record, but you should not hesitate to use at least the grid suppressors if you suspect trouble of this kind. This precaution, of course, extends to any of these extremely high-Gm valves.

Building the amplifier should not present any difficulties. The chassis we used was that originally designed for the Playmasters No. 7, and the general layout is much the same as for these amplifiers. There is nothing very critical about the placement of the parts, and when you get down to the job you will find most of the components between the valves will fall fairly logically in place.

You will notice a couple of large tag strips, one mounted almost under the power transformer and another between the input socket and one of the EL84's.

High-voltage feed points for the intermediate valves are located on the first, plus the plate decoupling resistor, and the filament leads from the transformer.

The other supports items such as the 10K cathode resistor of the 12AU7 and, near the 6AU6 socket, the feedback resistor and resistors. Coupling condensers tuck away almost in a direct line between plates and grids, although one connecting to the EL84 near the chassis edge is terminated at the second tag strip for firm mounting. The cathode resistors and bypasses for the 6AU6 and EL84's can clearly be seen in the photograph.

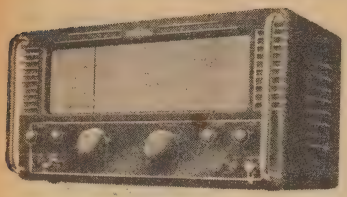
The filter condensers are mounted at one side of the chassis beneath the filter chokes, and are connected to a third tag strip at their "hot" ends. Leads run from them to appropriate circuit points, and the leads from the choke are also terminated at this strip.

The space under the output transformer is left clear to give easy access to the leads or terminal strip, as the case may be. If your transformer has no terminal strip, use a tag strip to terminate them, or alternatively the leads may be run direct to the EL84 sockets.

Use ½-watt resistors of a good make for the higher values, and wire-wound resistors for the EL84 bias,

COMMUNICATIONS RECEIVERS

EDDYSTONE MODEL "750"



£135/3/- (inc. Sales Tax) Speaker extra).

Width 16¾in, depth 10in, height 8¾in.

FREQUENCY RANGE: Band 1—32 to 12 Mc.; Band 2—12 to 4.5 Mc.; Band 3—4.5 to 1.7 Mc.; Band 4—1465 to 480 Kc.

VALVE LINE-UP: Eleven valves perform the following functions:—

R.F. Amplifier	6BA6	Det., A.G.C. and A.F.	DH77
Mixer (S.F. to 1620 Kc.)	ECH42	N.L., S. Meter Diodes,	6AL5/D77
Oscillator	6AM6/Z77	Output	N78
Freq. Changer (to 85 Kc.)	ECH42	Beat Freq. Oscillator	6BA6
		Rectifier	5Z4G
I.F. Amplifier	6BA6	Stabiliser	VR150/30

ELECTRICAL PERFORMANCE: Double Conversion Superheterodyne. Sensitivity is better than 5 microvolts for a 15 db signal/noise ratio.

SELECTIVITY is variable over the range 30 db to 60 db down 5 Kc. off resonance. Image ratio better than 40 db at 30 Mc., greater at lower freq.

AUTOMATIC GAIN CONTROL: Output level is maintained within 15 db for a 90 db change of input, above 3 microvolts at 8 Mc.

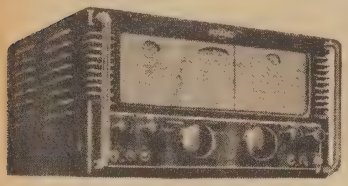
AUDIO OUTPUT: Max. output is 3.5 watts. Pick-up terminals are fitted and audio stages give linear amplification over a wide frequency range.

S. METER: Socket at the rear accepts Cat. No. 669 Signal Strength Meter.

DEPOSIT £45/3/-

Repayments as low as £4/8/6 per month

EDDYSTONE MODEL "680X"



£209/1/- (inc. Sales Tax, Speaker extra).

Width 16¾in, depth 13¾in, height 8¾in.

FREQUENCY RANGES: Band 1—30 to 12.3 Mc.; Band 2—12.5 to 5.3 Mc.; Band 3—5.7 to 2.5 Mc.; Band 4—2.5 to 1.11 Mc.; Band 5—1120 to 480 Kc.

CIRCUIT: Fifteen valves perform the following functions:—

Two R.F. Amplifiers	6BA6	Push-Pull Output	6AM5/EL91
Frequency Changer	6BE6	Beat Freq. Oscillator	6BA6
Separate Oscillator	6AM6/Z77	Noise Limiter, S Meter,	6AL5/D77
Two I.F. Amplifiers	6BA6	Rectifier	5Z4G
Detector and A.G.C.	6AL5/D77	Voltage Stabiliser	VR150/30
Two Audio Amplifiers	6BR7		

ELECTRICAL PERFORMANCE: Sensitivity for 50 milliwatts, 15 db signal/noise, 4 microvolts or better on all ranges.

SELECTIVITY: Bandwidths at 6 db down—Minimum 14 Kc.; first intermediate 7.5 Kc., second intermediate 4 Kc., maximum 2.5 Kc., and greater with crystal switched in and phased.

AUTOMATIC GAIN CONTROL: 9 db change of output for 100 db change of input, above 1 microvolt at 9 Mc.

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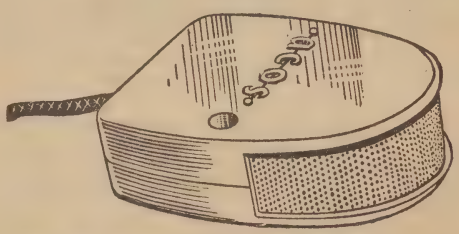

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Provided with built-in shunt resistance of 2 megohm giving response substantially flat from 50/5,000 cps. Resistance of the input circuit will reduce the low frequency response. A grid leak of ½ megohm will reduce the output at 500 cps by 3 dbs and pro rata at lower frequencies.

Approximate capacitance of the microphone is 750pF and cable capacitance will reduce output proportionately.

Frequency response	Substantially flat from 50/5,000 cps.
Output level	= 55 db ref. 1 volt/dyne/cm2.
Load resistance	2 megohms included.
Cable	This microphone is supplied with approximately 4ft. 1.2 metres of co-axial cable (type Unirad 32).
Weight	Microphone only — 6oz. (approx. 170 grammes) complete with packing 7oz. (approx. 198 grammes).
Dimensions	Microphone only 2 7/8in x 2 1/8in x 7/8in plus cable. Complete with packing 3 3/8in x 2¼in x 2¼in.

Australian Agents: AMPLION (A'sia) PTY. LTD., Sydney, N.S.W

ind for the control unit decoupling
a tuner is used.

The control unit decoupler should educe the voltage at the feed point o about 230 to 250 volts. This re-istor plays an important part in voiding motor-boating due to the igh gain of the unit, and is there-ore more than merely a dropping esistor. Use 10,000 ohms without a uner, and about 5000 ohms with a uner. The value of the decoupling ondenser is shown as 24 mfds, but nore than this can be used with n extra margin for safety.

We tested the amplifier with the ighest gain control unit, and it was ree from motor-boating even with he gain control wide open and full ass boost. Naturally, you will never se the amplifier under such condi-ions. But careful attention to these lecoupling values is the answer to ny such troubles, as the amplifier tself is quite stable, and no im-rovement is likely by alterations to ither its circuit or values.

EEDBACK CONNECTION

When first switching on the am-lifier, be on the alert for violent scillation as soon as the valves warm p. This will indicate that the feed-back resistor is connected to the wrong side of the voice coil winding, nd is actually providing positive nstead of negative feedback. The ure is to reverse this connection, when all will be well. There is no asy way of getting it right except oy trial.

Be particularly careful, too, that ou have the screen taps connected o the right valves. These will in-ariably be indicated by the trans-ormer maker, and oscillation will robably occur if you get them wrong. But you will do no harm as long as you don't run the ampli-ier for any length of time with a wrong connection.

Note that the output transformer s mounted at a slight angle on the chassis. This is to avoid direct coupling between the transformer and the power supply, and may be easily checked.

When the power transformer is mounted and wired up so that it is safe to turn it on without short-circuits, connect up the power with no valves in circuit.

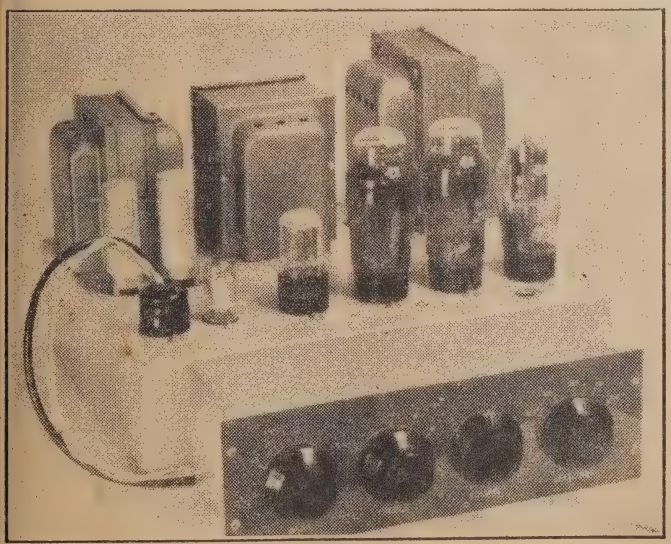
HUM CHECK

Now connect the speaker to the voice coil leads of the transformer and, before marking its exact position, try rotating it in its position on the chassis with your ear in the speaker cone to listen for hum.

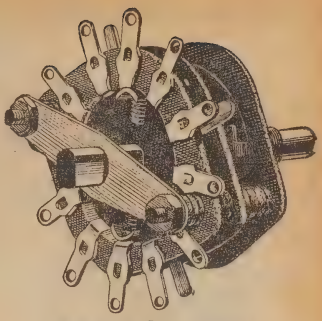
If coupling exists, you will hear a faint hum in the speaker, which will disappear when you rotate the transformer so that the mutual fields are not coupled. The exact position for no hum might be quite critical, and, having found it, mark the mounting position clearly so that the transformer can be bolted down at exactly the right angle. It may not look as tidy as if you lined it up for symmetry, but you may save yourself some time hunting for hum in the smoothing circuit which isn't there at all!

The residual hum level of the amplifier is extremely low. At a working setting you should not be able to hear any evidence that it is even in action unless you are quite close to the loud-speaker. With short-circuited input leads to guard against hum being introduced into the pick-up head, it should be perfectly quiet even with the gain open and extra bass boost.

There is really nothing more of a general nature that can be said about either of these amplifiers which has not been dealt with many times in other issues. Don't forget to make all your earths firmly to the bare metal, and use a separate earthing wire of heavy tinned copper to all such points if you wish to be sure. And, when you have it going, write and tell us how you like it!



This picture of the EL37 amplifier and control unit makes quite a handsome showing. The two units may be mounted together or separately.



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24V	250V 60MA	1	5	0
12V	270V 100MA	3	15	0
12V	500V 500MA	8	10	0
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★ DWR4	To suit 6J8, 6A8, 1C7 converters	Broadcast+ 5.9-18mcs	93/4
★ DWR5-13	To suit ECH35, 6AE8, 6AN7, converters	Broadcast + 7.2-23mcs	93/4
★ DWR5-16	To suit ECH35, 6AE8, 6AN7, converters	Broadcast + 5.9-18mcs	93/4
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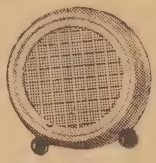

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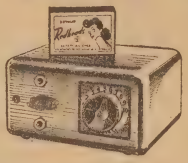
49/6



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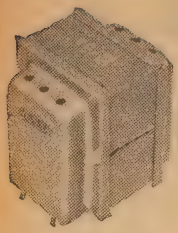

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PF 130F	230-240	285	100	6.3VCT/2A 6.3V/2A 5V/2A
PF 151	230-240	285	60	6.3V/2A 5V/2A
PF 151F	230-240	285	60	6.3V/2A 5V/2A
PF 152	230-240	285	125	6.3VCT/2A 6.3V/2A 5V/2A
PF 165	230-240	385	60	6.3V/2A 5V/2A
PF 170	230-240	285	80	6.3V/2A 6.3V/2A 5V/2A
PF 185	240	150	30	6.3V/2A
PF 201	240	225	50	6.3V/2A
PF 265	230-240	Secondary Volts		17 TAP 11.5, 10, 8.5/4.2A
PF 299	240	285	40	6.3V/2A 5V/2A

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PF 160	230-240	385	100	6.3V/2.5A 6.3V/2.5A 5V/2A
PF 164	230-240	325	100	6.3VCT/2A 6.3V/2A 5V/2A
PF 166	230-240	325	60	6.3V/2A 5V/2A
PF 168	230-240	385	80	6.3V/2A 6.3V/2A 5V/2A
PF 169	230-240	325	80	6.3V/2A 6.3V/2A 5V/2A
PF 173	230-240	425	175	6.3VCT/3A 6.3V/2A 5V/2A
PF 174	230-240	285	150	6.3VCT/2A 6.3V/2A 5V/2A
PF 175	230-240	385	150	6.3VCT/2A 6.3V/2A 5V/2A
PF 545	240	Ext. 1000	2	6.3V/3A 6.3V/6A
		350	20	4V TAP 2.5/2A
PF 439	240	32V	60	240-32 STEPDOWN

POWER CHOKES FIRST PREFERENCE

CODE No.	HY IND	D.C. RES.	D.C. MA
CF 102	15	300	60
CF 103	30	420	60
CF 105	15	250	80
CF 109	20	225	150
CF 196	20	130	125

POWER CHOKES SECOND PREFERENCE

CODE No.	HY IND.	D.C. RES.	DC MA
CF 106	12	200	100
CF 111	16	165	200
CF 112	10	70	250

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OP 9	15	10,000, 6600, 5000 PP	500, 250, 125	50-8000 C/S
OP 13	25	10,000, 6600, 5000 PP	500, 250, 125	50-8000 C/S
OP 24	5	5000 SE	8.4 OR 2.1	30-15,000 C/S
OP 25	15	10,000 PP	15-3.7 OR 8.4-2.1	20-30,000 C/S
OP 44	10	5000-2500 SE	500, 250, 125	50-8000 C/S
OP 54	10	5000-2500 SE	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2.	50-8000 C/S
OP 58	15	10,000, 6600, 5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2.	50-8000 C/S
OP 63	15	10,000 PP	15, 3.75	30-15,000 C/S
OP 112	6	10,000 PP	2, 8 SUIT ROLA 12 OX	40-12,000 C/S
OP 113	6	5000 SE	2, 8	40-12,000 C/S
OP 118	6	8000 PP	2, 8	40-12,000 C/S

OUTPUT TRANSFORMERS SECOND PREFERENCE

CODE NO.	WATTS	PRIM Z	SEC. Z	RESPONSE
OP8M	15	10,000 PP	500, 250, 160, 125, 100, 83.5, 7.5, 62.5, 55, 50	50-8000 C/S
OP 17	32	10,000, 6600, 5000 PP	500, 250,125	50-8000 C/S
OP 19A	15	5000 PP	12.5, 8, 2.3	30-15,000 C/S
OP 65	15	10,000 PP	8.4, 2.1	30-15,000 C/S
OP 67	15	5000 PP	15, 6.5	20-30,000 C/S
OP117	6	5000 PP	8, 2	40-12,000 C/S
OP119	6	6600 PP	2, 8	40-12,000 C/S
OP 60	32	10,000, 6600, 5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2, 2.7, 2.3, 2.	50-8000 C/S

VIBRATOR TRANSFORMERS FIRST PREFERENCE

CODE NO.	PRIM VOLTS	D.C. VOLTS	O'PUT MA	BUFFER FULL SEC.
VT 104	6	250	60	.004
VT 210	12	250	60	.006

VIBRATOR TRANSFORMERS SECOND PREFERENCE

CODE NO.	PRIM VOLTS	D.C. VOLTS	O'PUT MA	BUFFER FULL SEC.
VT 116	24	250	60	.005
VT 208	6	250	60	.01
VT 209	12	250	60	.08
VT 211	32	250	60	.005 ea. half

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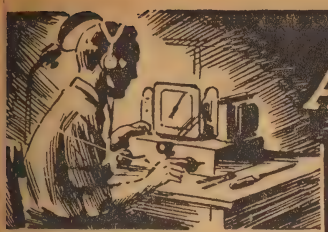
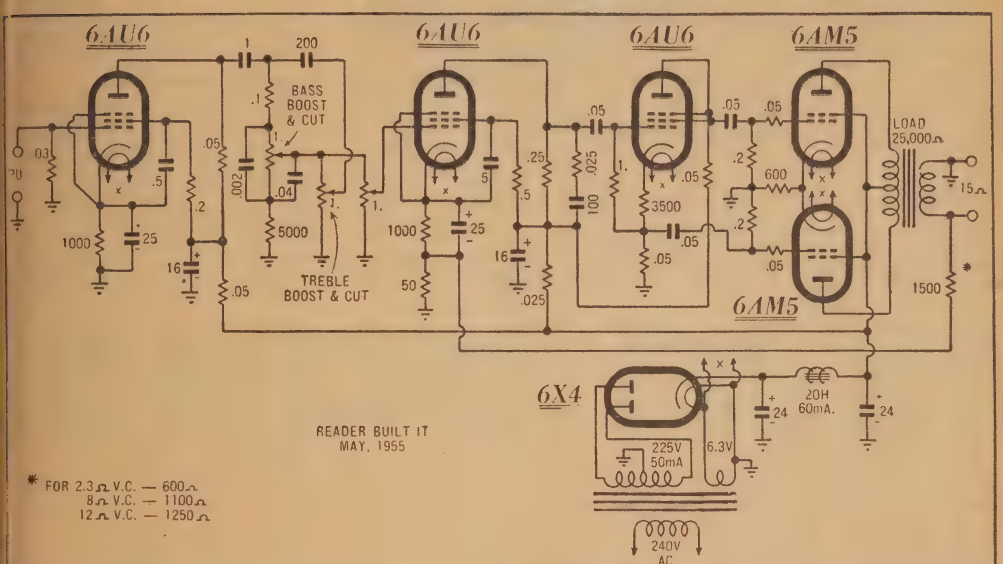


A READER BUILT IT!

Gadgets and circuits which we have not actually tried out, but published for the general interest of beginners and experimenters.

CIRCUIT FEATURES ECONOMY PUSH-PULL OUTPUT



For the audio enthusiast there always seems to be a new way of solving old problems and this contribution is an attempt to give most of the advantages of a large amplifier at a lower cost. It comes from Mr. J. A. Hazel, C/o Guild of Undergraduates, University of Western Australia, Nedlands, W.A.

THE two points of major interest in Mr. Hazel's circuit are the utput stage and the pre-amplifier nd tone control.

The output stage will be of parcular interest to those enthusiasts ho would like the advantages of push-pull system, but who do not equire a large power output and eel that the normal arrangements re unnecessarily large and expenive.

SMALL POWER SUPPLY

This stage is capable of 4 watts utput which, as Mr. Hazel points ut, is quite adequate for most reuirements, yet it needs only a very imple power supply—even simpler han for an equivalent single ended tage—and is only slightly dearer han a single ended stage.

It is designed around the 6AM5, very modest power output valve vith a 1.4 watt single-ended rating nd a 4-watt push pull rating. Two ralves in push-pull draw a combined plate and screen standing current of less than 25 mA, while the combined heater currents are .4 amp, less than for a single 6V6.

This makes possible a power supply consisting of a 225-volt, 50-mA power transformer, a 6X4 rectifier, and a 50 to 60 mA filter choke. For a push-pull amplifier it is difficult to imagine a more economical power supply.

The only other point regarding the output stage is the speaker transformer. Unfortunately there is no cheap way out of this problem and it would seem essential to use a good quality unit if voice coil feedback is to be used. The recommended load for the 6AM5's is 24,000 ohms and the more readily available 25,000 ohms would be perfectly satisfactory.

The feedback network as shown is designed to give about 16 db loss, though this could be modified to suit individual requirements. As it stands the main amplifier has a sensitivity of about 300 millivolts and the pre-amplifier will work with all but the lowest output pickups.

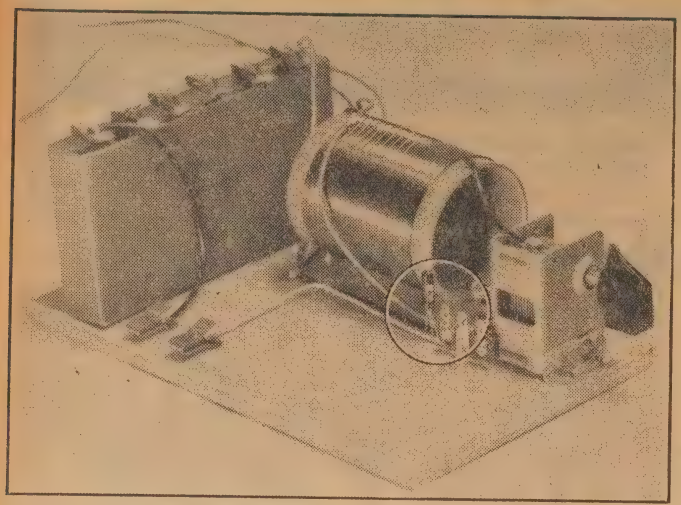
The two 6AM5's are driven by a 6AU6 in a conventional phase inverter circuit, driven, in turn, by another 6AU6 operating as a pentode driver. The simple top cut network in the 6AU6 plate circuit is a precaution against instability, though it was not necessary in the original.

PROBLEM OVERCOME

Ahead of the main amplifier is a tone control circuit featuring continuously variable bass and treble controls giving either boost or cut. The values given are claimed by Mr. Hazel to give the best possible compensation without undue lumpiness in the middle of the spectrum—always a problem with networks of this kind.

A further advantage of the circuit is that the miniature valves, along with the small power supply, makes possible a very compact chassis. The original was built on a chassis measuring only 8in square and 2in deep, the whole being cut from a 12in square sheet of metal.

Combined with an efficient loudspeaker, this amplifier would just about have the ideal size for occupants of flats, who cannot afford to enjoy music at loud volume.



Learn about transistors the practical way. This 1-transistor receiver is no harder to build than a crystal set and not very much more expensive either. But it works a lot better and more important, gives you a start in this new field of development. The transistor is soldered to the tagstrip as indicated.

YOUR FIRST TRANSISTOR SET

To most of us, transistors are new and rather mysterious devices, which cut across a good many of our current ideas, based on the use of valves. But don't let transistors bluff you. Here's your chance to learn about them the easy way—by building them into a small set and making them work for you.

by Neville Williams

BEFORE reaching for the soldering iron, however, it may be well worth while to spend a little time and space reviewing the development of the transistor from a laboratory curio to the types currently available on the local market.

It will be helpful also, to study the basic ideas behind the transistor —how they carry current, how they can detect and amplify signals; their general characteristics and their present limitations.

ITS FAMILY TREE

The transistor is really a direct descendant of the old-fashioned crystal detector, which most of us have used at one time or another. With the aid of a simple coil, a tuning capacitor, a pair of headphones — and a crystal detector — we have been able to listen to local stations, without any worry about batteries or power supply. One can hardly visualise anything simpler.

But the very simplicity of a crystal detector is also its chief limitation. It cannot amplify the incoming signals; it can only render them audible. If the signals are strong, then good volume is available from the headphones. If the signals are weak, then you can hear little or nothing of them.

Because people wanted to hear these weak signals, and on a loudspeaker into the bargain, crystal sets and crystal detectors were put aside for valve circuits, which could provide enormous amplification.

Many enthusiasts, in those early days, experimented patiently with crystals, hoping to make them amplify by some manner of means. Most of their attempts were completely futile although, in the light of what we know now, it is possible that some of them really did "fluke" individual set-ups which were capable of amplifying or oscillating.

One thing is certain, however, namely that none of them had any real idea of the problem they were trying to solve.

No one really understood the basic principle of the crystal detector, let alone the means by which its usefulness could be extended.

In point of fact, the crystal detector largely remained a mystery until wartime needs concentrated on it a great deal of research. Lacking valves for use in extremely high frequency radar receivers, scientists found in the crystal detector a non-linear — or detecting — device capable of acting as a mixer in a UHF superhet.

In a rapid programme of development, scientists discarded most of the substances which exhibited "detecting" properties, settling on silicon and germanium —particularly the latter — as being the most promising for close investigation.

Metallic germanium is a rare greyish-white element, having 32 electrons in its atomic structure. In some respects it resembles tin, in others carbon and, in the pure state is useless for electrical applications.

A SEMI-CONDUCTOR

When produced in crystalline form however, and mixed with certain impurities, it acquires very unusual electrical properties, becoming what is known as a "semi-conductor". Let's see what this means.

In crystalline form, the atoms of germanium arrange themselves in a kind of "lattice" structure, as is usual with crystalline substances. The outer electrons in each adjacent atom align their respective orbits or rotation — a process that is largely responsible for the crystal's orderly homogeneous structure.

In other words we say that the outer electrons form "valence bonds" with each other.

In chemically pure, crystalline germanium, these bonds are quite stable and electrons will not readily migrate through the structure to support the flow of current. It behaves, in fact, as an insulator.

This is where the impurities mentioned earlier come into the picture.

ADDING IMPURITIES

If a minute trace of phosphorus, arsenic, antimony or some such element is added to the germanium, while in the molten state, the normal crystal lattice is unbalanced by the presence, here and there, of "foreign" atoms having five instead of four electrons in their outer orbits.

The fifth electron is not absorbed into the system of valence bonds and is able to migrate under the influence of an externally applied electric field. Thus electrons can pass into and out of the crystal— in other words a current can flow through it—by displacing electrons not held in tight valence bonds.

Elements which can thus provide a surplus of electrons are called "donor" elements and a section of

ermanium crystal containing a sur- us of "donor" impurity is known "N" type, because it is negative in haracter. It could hardly be any- ing else because it contains extra ectrons!

Certain other elements like boron, dium and aluminium, which can ccessfully be introduced as impuri- es, have only three electrons in their ter orbits. They also upset the sic crystal structure by leaving val- nce bonds here and there incom- ete.

Under the influence of an extern- ly applied electric field, individual ectrons may migrate to fill these nds, leaving behind a gap in the ructure. This is an "open invita- n" to other electrons to move in that, once again, we have a move- ent of electrons—and a flow of rrent.

TYPE GERMANIUM

Impurities which produce this state affairs are referred to as "acceptor" ements and germanium which con- ins a preponderance of "acceptor" npurity is referred to as "P" type. his is logical enough, because the ps in the crystalline structure pro- de an attraction for electrons, just if the piece of crystal were actu- ly positive in character!

And here we encounter a rather range term. Because these gaps in e structure provide the vehicle by hich electrons can move and cur- nt can flow, it is conventional to isualise such current as conduction y "holes". Let's say it again— oles!

As electrons move in one direction, e visualise the spaces they leave ehind—the holes—moving in the ther.

It rather reminds us of what hap- ens in a movie theatre. When the retty usherette asks the patrons to move along please", the person on e far end of the row moves into e seat near the wall. That leaves vacant chair which the next person ccupies. So the shuffle goes on, e patrons moving away from the sherette, while the "hole" moves ward her! Then she shows her oyfriend into the seat!

That may or may not have helped larify the picture in your mind but is important to memorise the facts nyway: (1) Current flows through -type germanium because its tomic structure naturally contains a floating population" of free elec- ons. (2) Current flows through P- ype germanium because its atomic tructure naturally contains a "float- ng population" of holes, which be- ave like positive changes, and pro- ide "stepping-stones" for electron ovement.

HOW DIODE WORKS

With this bit of basic theory be- ind us, we are in a better position o understand how the germanium iode works. The transistor is a tep beyond that again. But first the iode.

In its simplest form, a germanium iode is manufactured by resting a iny contact wire—the "catswhisker" —against the surface of a piece of -type germanium crystal. A high urrent is passed momentarily hrough the junction.

It is thought that this current and the consequent heat produced at the point of contact disrupts the N-type crystal "lattice", drives some elec- trons away from the area by brute force and creates a small amount of P-type germanium around the end of the "catswhisker".

In other words, the structure in this zone is unbalanced (figure 1a) by having more than a fair share of "holes" while the body of the crystal still has a surplus of electrons.

This is the normal state of affairs in P-type and N-type germanium and the two types can exist on either side of the junction zone without any marked tendency for electrons to move across the junction.

But what happens if an external potential is applied across the diode structure, between the "whisker" and the body of the crystal—in other words the "base"?

If the "whisker" is connected to the negative side of the circuit, as in figure 1b, electrons tend to drift away from the negative battery pole, filling the "holes" in the P-type region around the junction. They naturally leave "holes" behind them so that, in effect, the holes drift back away from the junction toward the negative battery terminal. This is what you would expect anyway, seeing that the holes act like positive charges.

Similarly, the surplus electrons in the N-type region drift away toward the positive battery pole. Thus the active charges within the unit are all withdrawn from the junction area, very little current flows across the junction and, in effect, the diode does not conduct.

But reverse the battery (figure 1c) and everything else reverses, too!

If the whisker is made positive, the "holes" tend to concentrate near the junction while the surplus elec- trons from the N-type crystal do likewise.

DIODE CONDUCTS

The result is a foregone conclu- sion: Under the influence of the ex- ternal field, electrons move across the junction into the holes. Else- where, the fragment of P-type ger- manium around the end of the whis- ker loses other electrons to the posi- tive side of the circuit, creating new holes while so doing. This means more incoming electrons, more holes, more movement and our diode is conducting.

It is, in fact, a rectifier, passing current in one direction, but not in the other.

Apply to it the alternating signal

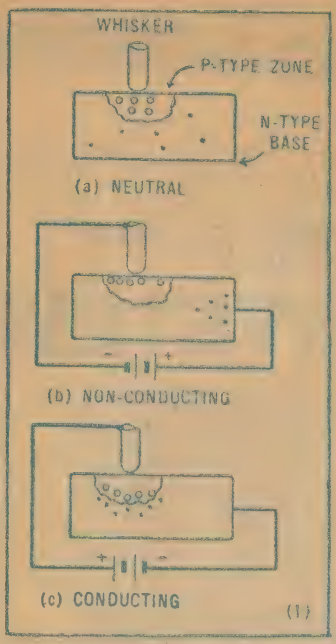
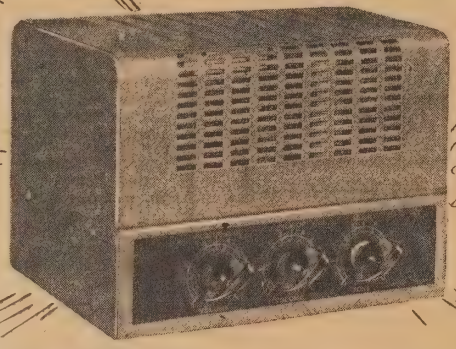


Figure 1: Understand this and you're well on the way to visualising the operation of germanium diodes and triodes. Current flows (b) when the externally applied voltage causes holes and free electrons to drift together near the junction.

Here are some of the transistors used for our experiments, photographed at about normal size. The two T-shaped transistors at the top centre are STC point contact types, while the one below them is made by Mullard. The half-dozen black units are Philips junction types.

You can take it with you !

PHILIPS PORTABLE P/A SYSTEM



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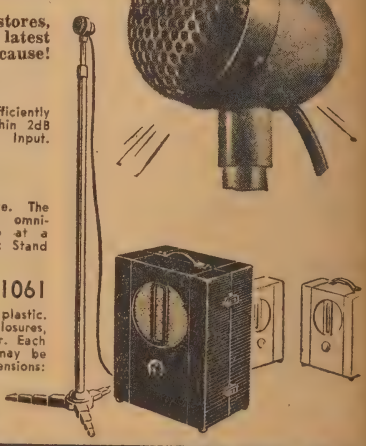

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om a station carrier and it will erate forthwith as a detector. This ct we knew, of course, before we arted. Let's hope that we now nderstand something of the reason hind it.

Under pressure of wartime research, scientists and engineers rapily refined the construction of germanium (and also silicon) diodes. hey were reduced in size, render- virtually shockproof, sealed hermetically and manufactured to fairly iform characteristics. They were oduced in quantities to sell — as ey do nowadays—for a few shilngs apiece.

Scientists discovered, furthermore, at the rectifying action would take ace wherever N-type and P-type nctions could be created and by hatever means. The "catswhisker" ea was only one of them—but more this anon.

Always before their eyes dangled e vision of what might be accomished if only this old but re-styled evice could be made to amplify. ut how?

WO CONTACTS

The answer came when two "catshiskers" were mated to the one rystal, a few thousandths of an inch part. It was found that a current owing through one catswhisker cirit was affected by current through ne other.

The degree of interaction was such at a signal on one electrode, repreenting a certain level of power, was nown to be capable of controlling a gnal of much greater power on ne second one. In other words, an amplifying crystal"—a transistor—as shown to be a practical proposion.

From that moment the race was n to develop and perfect the new evice.

Let's see how the transistor works, hen. Let's try to put into simple lanuage what is really a very complex henomenon; to get the basic idea, eaving the finer points to later and nore specialised articles.

To begin with, let's forget the word catswhisker" and substitute "point" r "point contact". That brings our erminology up-to-date.

Well, then, if two points are rought into contact with an N-type ermanium base and suitably "fused", ve create something like a germanum diode (figure 1a), except that t has two contacts and two P-type ones, side by side, in the one N-type ase.

RANSISTOR TERMS

It can be regarded as a P-N-P. ransistor of the "point contact" type nd represented by a diagram such s figure 2.

Since we may as well adopt transistor parlance at this stage, we shall egard the left-hand contact as the nput electrode, and call it the emitter". The output electrode we hall call the "collector".

Now to see what happens when xternal voltages are applied to these wo electrodes.

From earlier discussion on diodes t will be apparent that a positive oltage on the collector would cause a very heavy current to flow between t and the base. Even if the current were not sufficient to damage the

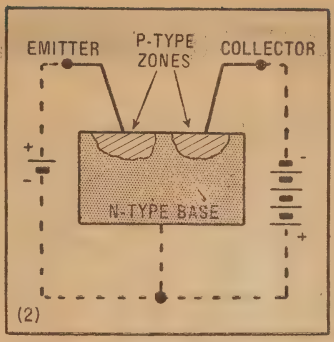

Figure 2: Illustrating the principle of a transistor. Charges from the emitter circuit, which is normally conducting, reach the collector and promote a current through its output circuit, despite the reverse voltage applied to it.

crystal structure, it would suggest a very greedy and inefficient device.

Placing a negative potential on the collector, on the other hand, would presumably prevent current from flowing in the collector circuit, rendering it a rather futile arrangement. Very true, but we have yet to consider the effect of the emitter.

If a small positive potential is placed on the emitter, it will conduct and a "forward" current will flow between emitter and base. The reason for this current we have already explained.

Electrons tend to move from the P-type zone beneath the emitter, up through the emitter to the source of positive potential. The holes they leave behind tend to move in the opposite direction, toward the junction area.

COLLECTOR CURRENT

Here, some of the holes combine with electrons from the N-type base to sustain current in the emitter circuit. However, many of the "holes" drift away toward the region around the collector contact which, you may remember, is at a negative potential. Electrons from the collector's negative supply then diffuse through the P-type region to fill the holes made available from the emitter circuit.

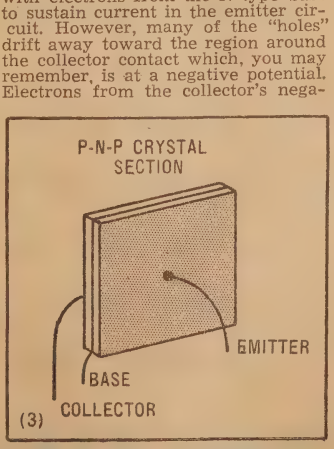

Figure 3: Heart of a junction transistor is a tiny wafer of crystalline germanium in which P-type and N-type layers have been produced in close association

In other words, current begins to flow in the collector circuit, even though it is held by its supply in a normally non-conducting condition.

However, it is easy to see that the collector current is entirely dependent on the emitter circuit. Let the emitter potential fall to zero and the collector current will virtually cease. Gradually, apply a positive "bias" to the emitter and the collector current will rise with it, depending on the number of "holes" available to carry current.

If the emitter receives an alternating potential, collector current will flow over the positive half-cycle but not during the negative half-cycle. In other words, we have got ourselves a device which will rectify incoming signals as well as being able (allegedly) to amplify them.

But let's have a closer look at this matter of amplification.

INPUT/OUTPUT CURRENT

On the surface, the prospects don't look too bright, because the whole inference of the preceding explanation is that current in the collector circuit is merely a diversion of current from the emitter. Therefore collector current could never be higher than emitter current and there could be no current gain (or amplification).

Actually, this is not quite right because, for some rather strange reason, the collector current in point contact transistors can be two or three times higher than the emitter current which promotes it. Possibly this has to do with the strong fields set up by large concentrations of electrons and/or holes. Another tentative explanation involves rather obscure effects in the collector junction region.

Perhaps it is best to leave such arguments to the experts at this stage and content ourselves with the facts:— With typical transistors the ratio of a CHANGE in collector current to the CHANGE in emitter current which produces it may vary from something less than unity to about five times, at the most.

Perhaps you're disappointed at this modest figure? Before drawing final conclusions, let's work out together a very simple but very informative little sum, based on the input and output impedance of a hypothetical transistor.

As we have already seen, the operation of a transistor depends on having a bias or a signal on the emitter which makes it conductive. The emitter therefore presents a quite low impedance to the input signal, normally amounting at the most to a few hundred ohms.

HIGHER IMPEDANCE

Let's assume, purely by way of example, that the emitter input resistance is 200 ohms and that we are applying to it an input which causes a current change of 0.5 milliamp. If we work this out on the basis of current-squared times resistance, we discover that the input signal represents a power of .05 milliwatt.

On the other hand, you will re-

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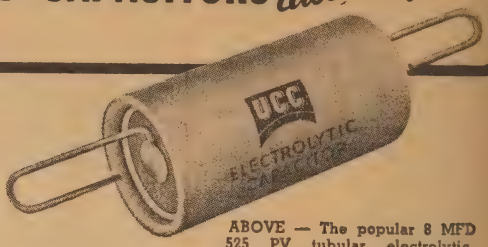

ABOVE — The popular 8 MFD 525 PV tubular electrolytic, cardboard sleeved, with pigtail connections — shown full size.

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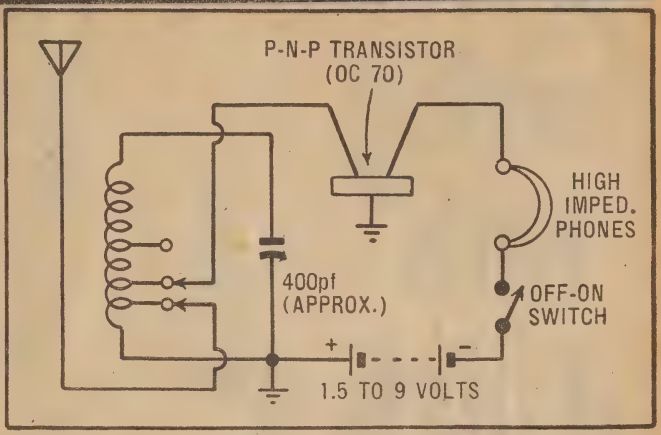

Figure 4: In many ways the circuit is similar to a crystal set but there is one vital difference. The signals you hear are amplified by the transistor, which draws its supply from a small battery.

cl that the collector operates with a reverse voltage applied and, were i not for the presence of an active emitter, it would not pass current a all. As it is, its impedance is cite high and generally amounts t several thousand ohms.

Let's assume, then, that the col-l·tor output impedance is 10,000 ems and that its output current i of the same order as the emitter crrent—0.5 milliamp.

If we work this out in terms of rwer, we find that it is equivalent t 2.5 milliwatts. In other words, ·en though we have reckoned the iput and output current to be the sme (i.e., no current amplification a all) the power gain has been sown to be 50 times.

ORMALLY THAT WAY

And that's the way it normally orks out with transistors. The rrent amplification is often less tan unity and seldom greater than ; or 3 times, but the enormous tfference between input and out-ut impedance accounts for a sub-antial power gain.

To realise this gain in practical rcuits, the designer must norm-ly arrange for each transistor to ceive its input signal from a low ipedance source and to deliver its utput across a load of several thou-nd ohms. There is no special roblem about this, although it does appen to be the reverse of con-ditions in a valve circuit, where the put impedance is higher than the utput impedance.

Well, then, let's see how far we've rogressed. We've studied the ovement of current through crys-lline germanium; we've seen how ermanium diodes and triodes ork; we've seen how a transistor n amplify and discovered the asic requirements of its input and utput circuit.

LITTLE MORE THEORY

Let's tuck away a couple more asic facts and we'll be ready to esign our first transistor receiver. n fact, you can switch on your oldering iron right now!

Thus far we have made specific eference only to "point-contact" ype transistors. We did this de-berately, because one's thinking an progress easily from the old-ashioned catswhisker and crystal o a germanium diode and thence o a device with two point contacts esting on the same germanium base.

You may, however, recall our re-mark that rather similar effects can e traced wherever P-type and N-ype semi-conductors exist side by ide. This is nothing less than the ruth.

By way of example, it has been ound possible to create P-type and N-type zones in a crystal structure y introducing impurities into the nolten metal while the crystal is n the actual process of being with-lrawn from it. When the crystal s later cut into sections, tiny wafers an be taken from it containing P-type, N-type and P-type layers n that order.

Connection is made to the three ayers by suitable means and we ave a P-N-P transistor "junction ype", incorporating what we call "grown" junction. (See figure 3.)

Junction-type transistors can be nade by other means, but our job ight here is not to discuss how to make transistors but how to use them.

Then again, transistors can be produced as N-P-N types, having two N-type outer regions and a P-type base. Their behavior is somewhat different from the P-N-P types, but we can afford to pass them by for the time being.

Our best plan right now is to concentrate attention on currently available point-contact and P-N-P junction types.

What then is the present supply and price position?

Up till quite recently, the price of transistors has been prohibitive for private experimenters, so that there has been little incentive to buy from the rather limited stocks held locally.

The stock position is now improving rapidly and at least one advertisement in this current issue indicates also that the price of transistors is on the way down. They are still dearer than valves, to be sure, but not too expensive for an experimenter who wants an odd one for a small set.

WHAT'S THE DIFFERENCE?

But what practical difference is there between point contact and junction types? How do they compare in the matter of performance? Which type is likely to become the more popular?

We went into these questions and managed to assemble a fairly reasonable picture from the information available. Here it is:

Most of the initial development centred around point-contact type transistors, as already indicated in the early part of the article. They were developed by various firms to the state where they were quite useful for electronic applications, notably in switching and computing circuits.

They proved useful also, for certain audio applications and, in special cases, for RF work.

However, the manufacturers found it very difficult to maintain uniform characteristics and their attention was turned to other possible methods by which this might be achieved, as well as speeding production and providing a more robust assembly.

Promise of these things was found in the junction transistor, along with greater electrical efficiency, and a great deal of time and effort is being put into their development.

Many problems still remain to be solved, however. There is no assurance that the "best" method of producing crystalline junctions has been discovered; dissipation figures are rather on the low side and, what is even more serious, gain falls sharply above about 500 Kc.

Engineers seem optimistic that these limitations will prove to be of a temporary nature and that junction transistors will soon forge ahead of the point contact types. At the moment, there isn't much to

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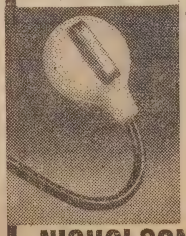
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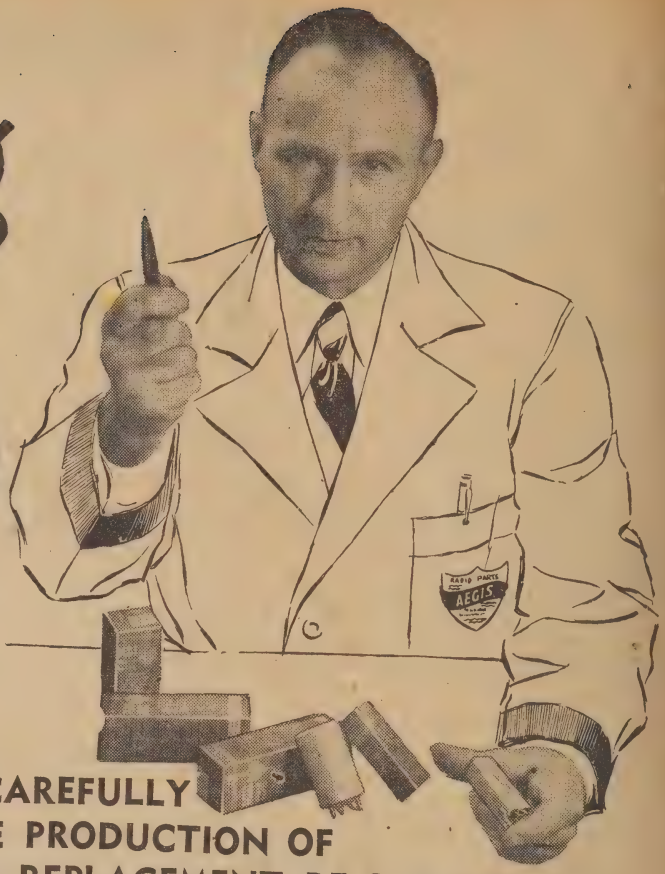

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oose beween them—at least for r purpose.

Because of this general position d because they happen to be eaper at the time of writing, we ve specified a junction type for r first transistor set. However, you have a preference for one the others, by all means use it.

Results may be similar, slightly tter or slightly worse according the merits of the transistor you tually wire into circuit.

And what are these results likely be? Perhaps we should introduce r little set by first answering this estion.

RFORMANCE

Unless you are extraordinarily rtunate, you will not be able to ild a 1-transistor set, which will val a 1-valve set in ultimate perrmance. You can't expect to lvet-smooth reaction and covere, by plug-in coils, down into the sort-wave bands.

As yet, production-type transistors en't as good as that.

You will be much nearer to ality if you regard this present sign as "a crystal set which amifies". If, at a later date, you can ake it oscillate and reap some nefits therefrom, you can regard it something extra for your money.

The prime objective, right now, is get the set working, observe the in of the transistor and its amazg economy in battery drain.

With loud signals coming from e headphones, you will be hard put it to find a transistor anywhere hich will draw more than a millimp from a 9-volt battery. Most of em draw less than a quarter-illiamp. This is the total drain of e set, because there is no filament rcuit to worry about.

We have made no attempt to dress up" the original set, because was built primarily for experiental purposes. In due course, we ant to use it to determine results ith different transistors and differnt connections, methods of obtainng reaction and the addition of an dio stage.

You can follow suit, if you have milar ideas. Alternatively, there no reason why it cannot be lamorised as much as you like and resented to the son as a "going oncern".

VORTH EXTRA COST

Our own reaction to the receiver that it completely outmodes crysl sets, the extra cost of the transtor and a battery being more than stified by the results obtained.

Our experimental set, pictured on ne first page of this article, was uilt up on a scrap of 3/8in plyood, measuring 8in by 5in. This as large enough to accommodate he parts we had on hand, leaving oom for experimental additions ater.

The tuning capacitor can be any f the current types, as long as t has a maximum capacitance of bout 400 pf (.0004 mfd). An ordinry knob or plain dial will do for uning, since it is not critical to handle.

Making the coil is the most diffiult part of the construction. In oint of fact, the coil is identical with those specified some months ack for the "De-Luxe Crystal Reeiver". It should be wound, for preference, with 22 B & S enamel wire, on a 3in length of 2in diameter former. Other wire may be used, slightly thicker or thinner, but it will make some difference to the length of the winding.

Here are the winding instructions, repeated from our earlier article:—

"Assuming the use of 22 B & S enamel, drill two small holes close together and 3/8in in from each end of the former.

"Have a wooden match handy, with the head trimmed off, because you will need it to support the tapping points.

"Now loop one end of the wire a couple of times through one set of holes and proceed to wind on five turns, keeping the wire taut and the turns placed accurately side by side.

"Slip one end of the match under the fifth turn and then pass the sixth and succeeding turns underneath the match again.

"When you get to the 10th turn, push the match along and run the 10th turn over the top of it, the 11th and succeeding turns going underneath again.

"Continue in this fashion until you have wound on 50 turns, with a tapping every fifth turn. Far from complicating the winding, you will find that tappings made in this way help you to keep good count of the turns."

"After the 50th turn, wind on 30 more, to make 80 turns in all. The 80th turn should be looped a couple of times through the holes in the end of the former and this much of the job is complete."

Add a couple of mounting brackets and carefully scrape the enamel from the raised turns so that leads can be soldered thereto as necessary.

As you can see, we screwed a couple of battery clips to the baseboard to take the phone leads.

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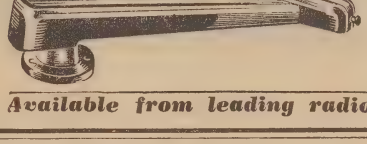

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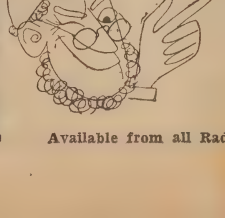

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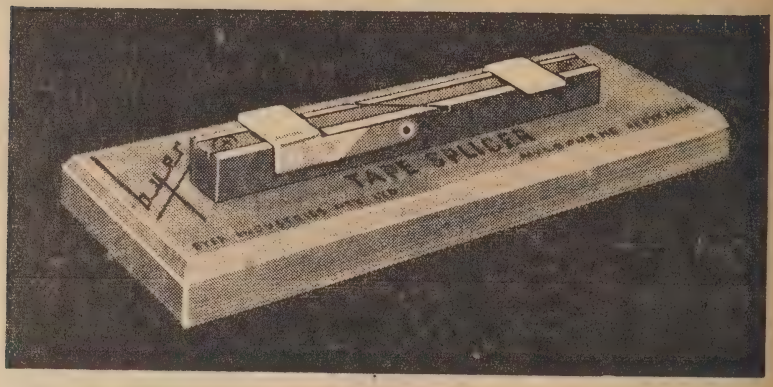

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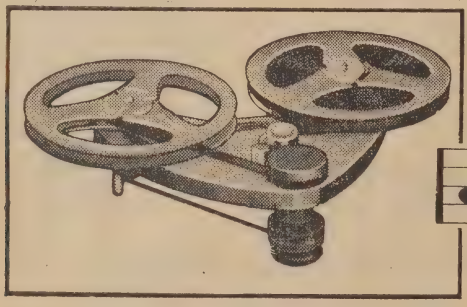

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eing an experimental set-up, we
ic't bother with an "off-on" switch,
h battery simply being discon-
e ed after we had finished with
t. A switch can be added very
irply, however, as indicated in the
ir uit.

ne only other item is a 3-tag
tr, screwed to the baseboard and
e ing as a mount for the tran-
sir. All these components dwarf
n transistor, of course, but we are
ycried about behavior, not size!
Tre will be time enough later to
tit building things in a match-
bo!

you use a Philips OC70, as
p ified, the thin railing leads can
e soldered directly to the lugs. The
e re lead is the Base connection,
h one slightly spaced away is
h Collector, while the remaining
r is naturally the Emitter.

miniature socket is available
d these transistors, the leads be-
n trimmed off short and pushed in
p the socket, rather like a sub-
n iature valve. It is hardly neces-
ar to worry about a socket at this
tie, however.

It the moment there does not ap-
pr to be any standardised basing
ar angement for transistors and
o er types which you may want to
u will have to be installed accord-
ir to their own special require-
m nts.

The Mullard OC51 point contact
ty e, illustrated elsewhere in the
ar cle, has two short, stiff prongs
p truding from it, rather like valve
pis. The straight prong is the
Emitter, the offset one is the Col-
lector, while the metal shell forms
th Base connection.

DAMAGE BY HEAT

It is most unwise to try to solder
to any of these connections, since
hat from the iron could easily
damage the "works" inside. You
will find, however, that the prongs
will fit adjacent holes in a Noval
wafer type socket, while a small
grid cap can be made to grip the
body of the transistor.

The STC point-contact types, also
illustrated earlier in the article, have
reasonably short, stout leads for
Emitter and Collector connections.
(Red sleeving indicates Emitter.)

The manufacturers say that these
transistors can be soldered into cir-
cuit but undue heating of the leads
must be avoided. The tip should be
carefully scraped and tinned first,
the lead being gripped by a pair of
pointed pliers between tip and body,
while this is being done. The pliers
help to conduct heat away from the
lead.

If, the leads have to be bent for
any reason, extreme care must be
taken to see that no stress is placed
between the lead and the body of
the transistor.

These are all very sound rules for
handling transistors of any type.

So much for the mechanical side.
Looking at the circuit, you will notice
that the aerial is tapped down to-
ward the earthed end of the coil. Its
position is best determined experi-
mentally, exactly as you do in a
crystal set.

Tapping the aerial up the coil
ends to increase the loudness of
signals in the phones but it also re-
duces the selectivity of the tuned
circuit. It's a matter of balancing
the factor against the other for best
all-round results.

The transistor is a big help in this
regard because, in making the sig-
nals louder, it allows the aerial to
be tapped closer to the earthed end
than would otherwise be the case.
Thus, in a rather roundabout fashion,
using a transistor improves the selec-
tivity. Our own set worked best
with the aerial only 5 turns from the
earthed end of the coil.

The transistor Emitter must like-
wise be tapped well down the coil.
This provides the necessary low im-
pedance input to it and also avoids
excessive shunting across the tuned
circuit.

We found that the input resistance
varies a good deal from one type
transistor to the next, some needing
to be tapped farther up the coil
than others. When photographed,
our own receiver had both aerial and
Emitter connected to the first tapping
— 5 turns up from the earthed end.

We have shown the Emitter con-
nected directly to the tapping with-
out the addition of two components
we generally look for in a valve
detector — the grid capacitor and
grid leak. These components are
not necessary to the functioning of
the transistor circuit, though they
are sometimes included to limit peak
Emitter current, should the transistor
be made to oscillate or be fed with

(Continued on Page 119)

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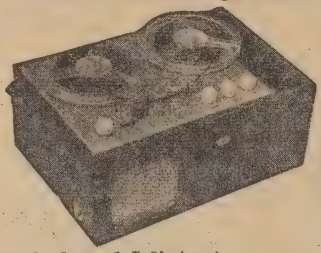

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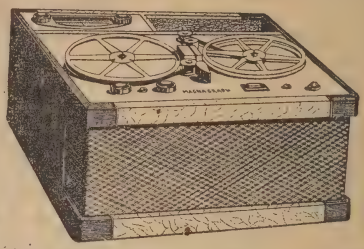

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Please send without further obligation details of.....

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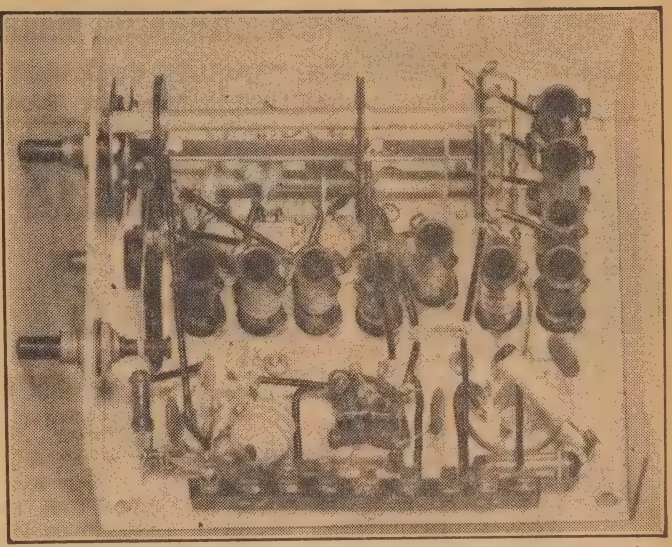
I enclose LARGE self-addressed envelope and 6d in stamps.

TRADE REVIEWS AND RELEASES

A HIGH STABILITY VFO UNIT

he use of variable frequency scillators for amateur trans- itters and other low-powered stallations has become universal nce the war where changes in perating frequency are called or. The success or failure of he procedure depends entirely n the stability of the oscillator nit and the method used to ouple it into the transmitter.



Under-chassis view of the Geloso unit showing the array of slug-tuned coils and the three valve sockets ready wired. The dial mounts on the front of the panel normally fitted to a transmitter.

many cases, ex-disposals units have been used as VFO's with e or less success, but, not being inally designed for their even- l employment, are not without advantages.

ne of these concerns calibration, another bandspread. Ease and tainty of handling are much more icult unless the unit in use pro- es for them.

or this reason, if for no other, Geloso Signal Shifter, a sample which has been sent to us for , should prove most attractive builders of amateur stations.

t is entirely self-contained with oscillator and two buffer stages, d-switched coils, and a large, ibrated dial covering all bands m 3.5 Mc to 28 Mc.

A 6J5 Clapp type oscillator covers ranges, and by suitable switch nection for the 6AU6 isolator ves and the 6V6 output stage, ases them to multiply in the rect ratio to give the desired dspread.

The unit is completely wired, with lantite sockets for the 6J5 and 6, and needs only mounting and ring into a suitable circuit. Inci- ntally with a plate voltage of 400, 6V6 will give at least 3.5 mills rent through a 25,000 ohms resis- Provision is made on the tag strip to connect its screen to a potentiometer, which may be used as an output control.

Our picture shows the really interesting part of the unit—the iron cored coils and clean wiring. All adjustable condensers are air-spaced, the remainder are silver-mica types. The unit is lined at the factory, and only minor adjustments will be needed.

Under test with a Cardwell frequency meter, the unit showed exceptionally good stability and low drift, of a standard far beyond that required for amateur work.

The unit is distributed in Australia by R. H. Cunningham & Co., of Wattletree Rd., Melbourne. List price with tax is £10/4/9.

DIAMOND TIPS FOR PICK-UPS

The use of diamond styli for gramophone pick-ups is slowly but surely coming into vogue. Many are beginning to realise that the high price of the diamond as compared with other types, is likely to be an economy when judged against the greatly extended life.

HIGH FIDELITY INDUSTRIES, of Parkdale, Victoria, have sent us a sample of a Shefi diamond stylus, in this case intended for the popular Acos GP4O crystal head.

The styli can be fitted to a number of popular heads, however, and all Acos types, BSR, Collaro GP-27, and Decca can be supplied complete with shank.

In addition tips can be fitted to Collaro O, P, or PX, Decca H and XMS, HMV and Garrard Astatic pickups on receipt of the shanks or armatures. The list price of the styli is £7/14/6.

It is hard to estimate exactly the life of any reproducing point, because so many variable factors are involved.

However, Shefi consider that with a good quality pick-up, correctly mounted, and used with records in good condition, 5-7000 LP sides should be played before serious wear becomes apparent. They consider that the diamond has a useful life 40-50 times that of a sapphire.

All Shefi diamonds are guaranteed against accidental damage for six months after the date of purchase.

An Acos GP40 head with the Shefi replacement diamond stylus beside it.

ACE RADIO

Amplification Communication Electronics

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EVENINGS and WEEKENDS: "KALUA", COLLAROY ST., COLLAROY—XW5956

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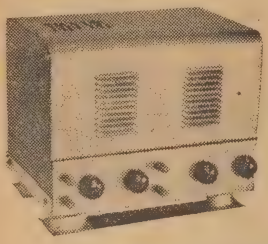

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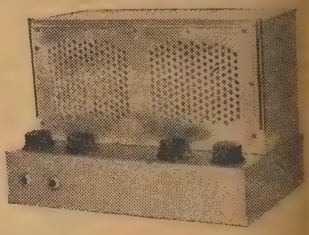

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7 VALVE 12 WATT 12V DC £17/17/6
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Complete with the amazing New Jensen A.U.53 Twin Cone Speaker. Cross over network. Mounting ring and spider. Frequency response 50 to 12000 cycles.

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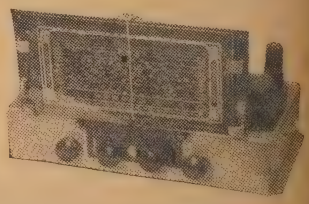

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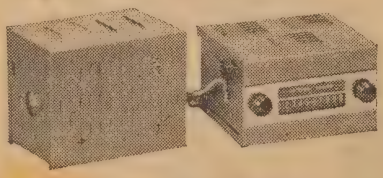

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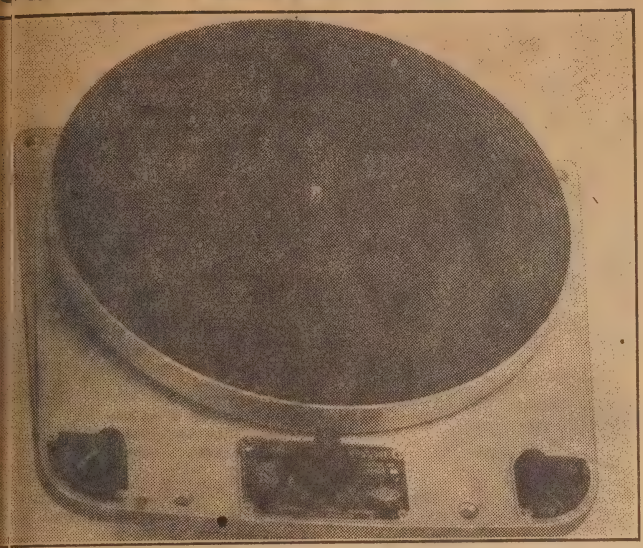
GARRARD TRANSCRIPTION MOTOR



PROFESSIONAL engineers and amplifier enthusiasts alike will be interested in a new transcription motor recently released by the Garrard Company of England. It is designated as model 301.

The motor is assembled on a heavy diecast base and is carefully engineered throughout. It has an "on-on" control on the left and a speed selector on the right, interlocked to prevent any damage to the mechanism by careless operation.

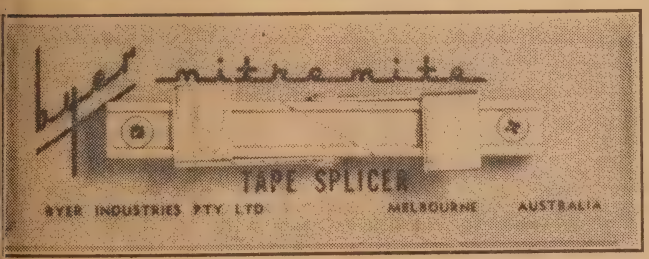
A rather unique feature is an eddy-current brake, which allows a variation of 2½ pc at any speed setting. This operates on the drive motor shaft, the whole drive mechanism being supported from a special cradle by three springs.

The turntable is cast and machined and each motor is individually calibrated in terms of wow and flutter. Maximum guaranteed tolerance is 0.2 pc wow and 0.5 pc flutter. A special bearing carries the turntable, using a special high-pressure lubricant.

The carton contains a further supply of this lubricant and an alternative pulley for 50 or 60-cycle operation. It will operate from voltages within the range of 110 to 240 AC, is electrically tropicalised and finished in grey hammertone enamel.

The sample motor shown above was supplied to us by Messrs. United Radio Distributors, of Phillip St., Sydney. List price is quoted as £38/6/6.

RECORDING TAPE SPLICING WITH A MITREMITE



SPLICING plastic recording tape is easy if you know how, and serious nuisance if you do not.

A particularly neat little unit from Byer Industries is the Mitremite tape splicer, with which tape breaks can be prepared easily and with a minimum waste of time.

As the picture shows, it is essentially a section of channelled aluminium into which the two broken ends are fitted.

The tapes are then cut through with a razor blade (supplied), using as a guide the slot already cut across the channel at the right angle.

The tape ends are held in place by two pressure pads which are hinged so that they can be flipped out of the way while the Mitremite is being loaded.

After the tape ends have been sliced, the join is made with splicing tape, and after a final trim the job is done.

A very handy accessory for anyone using tape.

Byer Industries are in Dorcas St., South Melbourne.

SCOTCH TAPE NOW AUSTRALIAN MADE

THE Minnesota Mining and Mfg. Co. (Aust.) Pty. Ltd. announce that they are now producing locally a wide range of genuine "Scotch" brand adhesive tapes. Tapes in production (or scheduled for production) include the familiar wrapping tapes for counter use, plus many special-purpose tapes, such as the Scotch electrical tape, recently reviewed in these columns.

Advice has been received from Messrs. Wm. J. McLellan and Co. Pty. Ltd., who are distributors of "Scotch" tapes, that genuine "Scotch-lite" reflective bumper tape has been approved for use as a reflector on the rear of motor vehicles.

They state that at least 4in to 5in of 1in wide tape should be used, no higher than 3ft 6in from the ground and commencing laterally within 16in from the outer extremities of the vehicle. It can be mounted on the rear bumper, preferably in a position where it is not unduly exposed to damage by collision.

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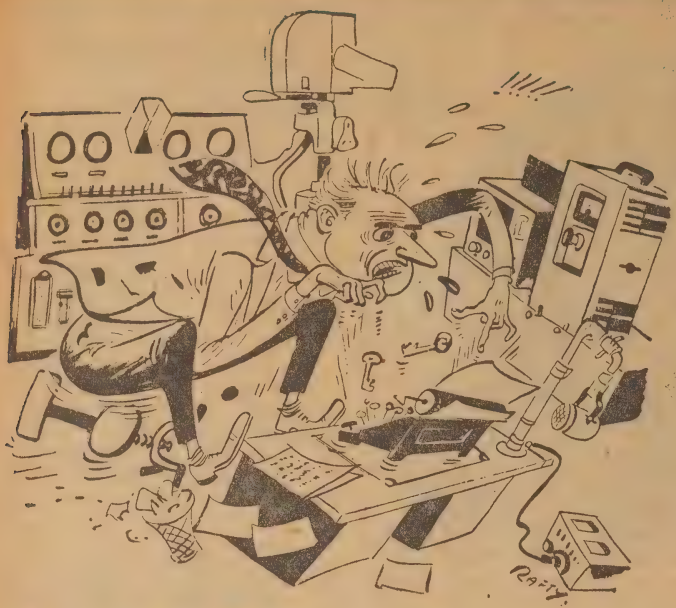


Let's Buy An Argument

Apparently, last month's discussion on the Ultra-Linear circuit was read with a good deal of interest. Quite a few readers mentioned their appreciation both of the original letter by A.H.F. and the relevant discussion by yours truly. Blushingly, we thank you.

by Neville Williams

WHILE not wishing to pursue the subject too much further in these columns — at least for this month — it seems appropriate to round off the discussion with a few snippets of the conversation and correspondence arising from the last article.

Said one reader:

"Of course it must be negative feedback, just as A.H.F. contends. The circuit isn't really very different in principle from the old Radiotron idea of taking negative feedback from one output plate back to the screen of a preceding voltage amplifier. The difference is that we are now operating at a higher level and injecting the feedback signal into the output valve's own screen."

OVER-SIMPLIFIES PROBLEM

That might be accepted as legitimate comment but I fear that it over-simplifies the problem and may not have much real value as a result.

The vital difference is that feedback to the screen of an early stage does not directly affect the potential gradient in the output valve (or valves). This undoubtedly happens with the Ultra-Linear circuit, as we showed last month and, in some cases, markedly reduces the power output.

A.H.F. had obviously taken this into account, though still wedded to the feedback approach.

Just the opposite point of view was put to us by another reader, whose opinions we must respect. Said he:

"The Ultra-Linear circuit cannot be regarded as a negative feedback circuit because it is not degenerative. It does not materially reduce the gain of the valve to which it is applied."

We have already concluded that the partial triode (or the Ultra-Linear) connection is more complex as prima facie evidence that feedback does or does not exist.

Along similar lines, another reader has gone so far as to suggest that we should disregard the feedback concept altogether and simply regard the partial triode connection as "a different valve in its own right". Perhaps a better term would be "a different application".

DIFFERENT DATA

If you want to use a valve as a tetrode, he points out, you base your design on the appropriate data. If you want to use it as a triode you refer to different data altogether, not worrying about the alternative connection.

"Think of the old 59, which, by appropriate connection to its grids, could be used as a high-mu triode, a low-mu triode or a pentode. It was, in fact, three different valves and was used as such. Why not adopt the same honest approach for the partial triode connection?"

And I can only repeat, "Why not?" It would be a perfectly logi-

in its effect than a simple feedback loop. Thus far we are agreed to reject the feedback idea completely, on the basis of gain alone, is a rather drastic step.

It may lead into speculation about "when is feedback not feedback" as we shall see later.

If one compares a set of pentode and triode curves, as we did in the March issue, it will be seen that there is, in fact, a difference in voltage gain between these two limiting conditions. For a 6V6 pentode (or rather tetrode) connection it is 1 as against 10 for triode connection.

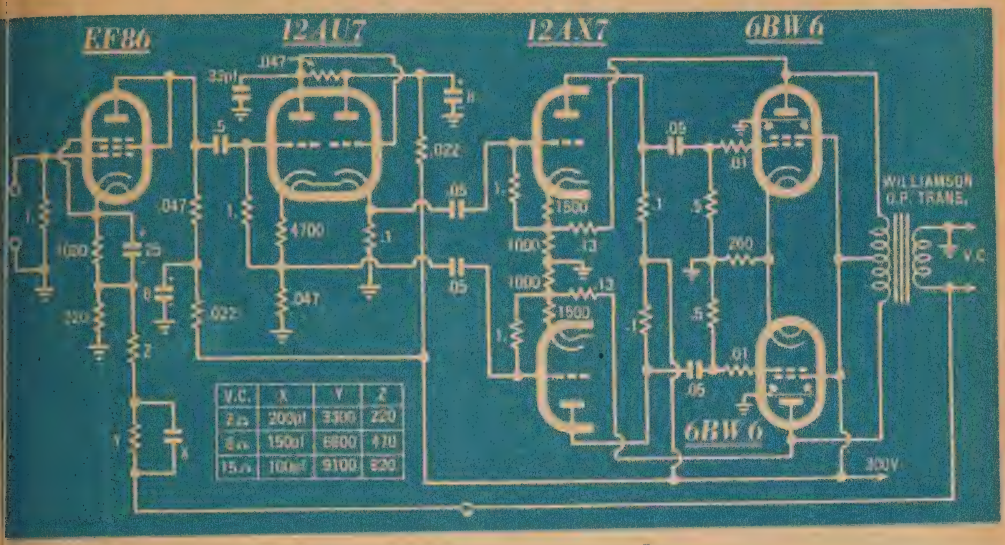
INTERMEDIATE FIGURES

With partial-triode operation, the gain figure would presumably lie somewhere between 10 and 15. While therefore showing some loss of gain in respect to the tetrode connection it would not be sufficient to suggest any worthwhile amount of feedback — in terms of gain, that is!

However, we must not forget that in changing progressively from tetrode to triode operation, the whole characteristics of the valve are altered. The transconductance goes up while the amplification and plate resistance come down.

We really have no common basis on which gain can be compared and I doubt that we can accept gain alone

USES NEW PHASE CHANGER, DUAL FEEDBACK LOOPS



Submitted by an industrious reader, this circuit illustrates two things: (1) The use of a phase inverter suggested a couple of months back in these columns and (2) the use of symmetrical drivers and local feedback around the output stage.

l thing to do. And it isn't a new ought by any means.

Back in the January issue, on age 95, the editor had this to y:

"The valve, in effect, becomes a new type, whose behavior merits further study to produce a set of working conditions as a guide to its best employment in the Ultra-Linear circuit."

NY CONFLICT?

On the surface, this may appear be a contradiction of what we've aid elsewhere. But is it? Is there eally any discrepancy between the feedback" concept and the "different valve" concept?

Think of it this way:

You get hold of a 6V6 and use as a tetrode. There is no ambiguity about its operation.

Now tie screen to plate, as for triode connection".

Tell me this: Are you now using a true triode stage or is it really a tetrode with 100 pc feedback to the screen?

Is the screen now merely a grid-like extension of the plate structure or is it still an active electrode in its own right?

Perhaps the two questions amount o the same thing. Is it not quite ogical to suggest that the application of 100 pc feedback to screen means operating the screen at the same instantaneous potential as the plate? That, in this limiting condition, the screen simply acts as part of the total plate structure and the valve, in effect, is a true triode?

If this be the case, then we can say that a triode-connected pentode (or tetrode) may be regarded either as a true triode or as a pentode with 100 pc feedback to the screen, both terms meaning the same thing!

Thus, when we refer to the triode plate family of curves for the 6V6, we may just as legitimately say that we are looking at the curves for a 6V6 with 100 pc screen feedback.

The curves exist as a separate set of data. They take full account of the multiple plate structure and exhibit quite ordinary values of mu, Rp and Gm.

The inference is obvious. If, instead of connecting screen directly to plate, we connect it only part way along the load, the valve might be said to act as a PARTIAL TRIODE or as a pentode with LESS THAN 100 pc SCREEN FEEDBACK, both terms again meaning the same thing!

WILL TELL ALL

If and when valve manufacturers release curves for "Partial Triode" operation, the data will constitute an application in its own right. The curves will assume a certain configuration, will reflect the total influence of the screen and exhibit new values for mu Rp, and Gm.

Then, perhaps, we'll stop arguing!

In the meantime we've gone round in a complete circle and just about agreed with everybody in the process. What happy people we are!

While in a mood to speculate, here's something else to chew over:

If the partial triode curves turn out to be so advantageous to designers of medium-priced, high quality amplifiers, what chance would there be of producing a valve with equivalent characteristics to begin with? Something like a power triode but containing a screen so coarse in pitch or so placed that it could boost plate circuit efficiency without having too much effect on output impedance?

An interesting thought!

On the strictly practical side, there seems to be a growing interest in cheap, low-power and (we hope) good quality push-pull amplifiers. The "Reader Built It" circuit elsewhere in the issue is an illustration of what we mean.

If one can assume that there is indeed a prejudice against single-ended amplifiers and that many domestic amplifiers need never produce more than two or three watts of peak power, why encourage all and sundry to pay for a large power supply and a large output transformer?

At least that is the view that has been put to us on several occasions recently.

It has been suggested, furthermore, that the Ultra-Linear circuit could help matters. By making a moderately good output transformer, it should be possible to use overall as well as screen feedback without too much trouble from phase inversion and consequent instability.

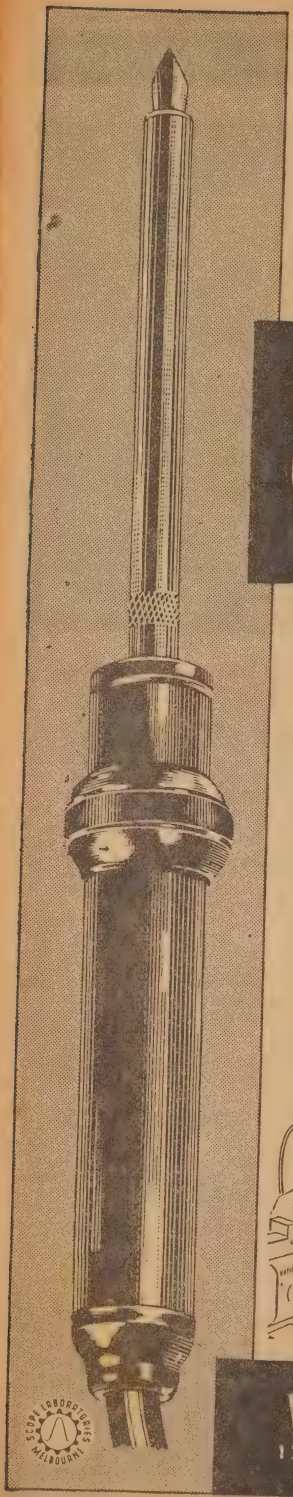
MEETING A STANDARD

In other words, if one sets a certain minimum standard of performance, consistent with moderately priced speakers and pickups, it may be easier to meet that standard more cheaply with an Ultra-Linear circuit than with any other.

Maybe it would! We shall have to think about it.

The amplifier circuit you see on this page was submitted to us by a reader from South Perth, WA.

It is of particular interest to us



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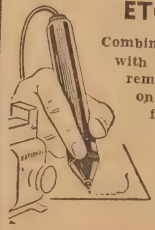

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e because it uses the type of cir-
y which A.H.F. had in mind in
s etter last month. It illustrates
ectly what I said about the extra
plexity which an auxiliary feed-
k loop often introduces.

The other point of interest is his
otion of a new type phase splitter
ch I suggested in these columns
uple of issues back.

Perhaps the obvious course is to
int what this particular reader
to say about his amplifier. I
e:

Sir,

*Allow me to congratulate you on
new phase-changer circuit. It
s really good to me.*

*I am enclosing a circuit, which I
e may be of interest, of an ampli-
which I have built up and which
ses the new phase-changer. It
uite a good performer.*

*In this case the phase-changer
ks into the grids of the 12AX7
ch present a fairly high im-
ance, because of the feedback
ied to the cathodes. Capacitive
ating is thus quite low and a 33pf
acitor on the phase-changer plate
ned to even up the balance at
high frequencies.*

*Actually a variable trimmer was
d and was adjusted until the right
ue was found at about 30pf. The
rall balance of the phase inverter
s measured in this circuit was not
pc but the unbalance was
digible.*

*The rather good performance of
circuit is largely due to the
iliary plate-cathode feedback
m the 6BW6's to the 12AX7. This
s ed through the .13 meg and 1000
m resistors without using a block-
r capacitor.*

*This raises the grid and cathode
entials of the 12AX7 two or three
ts with respect to chassis but has
undesirable effects. The grids
the cathodes of the 12AX7 are re-
ned to the junction of the .13 meg
d 1000 ohm resistors so as to pre-
e the correct bias from the 1500
m cathode resistors.*

*The degenerative feedback is also
ovided by the 1000 and 1500 ohm
mbination. Total feedback around
e output stage from these loops is
the order of 10 or 12 db. Since no
pcking condenser is used in the
dback path from the output plates,
ble operation and minimum
ase-shift are assured.*

*A high frequency phase-advance
work is used in the main feedback
p from voice-coil to the EF86
thode. With this provision the
plifier is entirely stable and oper-
s with a total of about 23-24 db
dback around the output stage.*

*The coupling capacitor to the
ase-inverter looks perhaps in-
dinately large, since it sees an im-
dance of about five megs in front
it, but this was found advisable
order to keep the phase-shift at
minimum right down to the lowest
equencies, especially since the
plifier has four stages.*

*The capacitor couples from the
w-impedance of the EF86 triode
ate resistance and, if it is kept rea-
nably well away from the chassis,
gh-frequency shunting can be
glected.*

*Using a Williamson OP trans-
rmer, 11 watts can be measured
the voice-coil.*

*It is advisable to check for match-
g in the components around the
12AX7 and to measure for balance in the output stage in order to ensure that there have been no gross errors caused by component tolerances, &c., but apart from this the circuit has no bugs and operates very smoothly.*

Yours faithfully, C.H.

And, if I may say so, I'm sure the circuit does operate very smoothly. However, the fact remains that it has one more valve and several more components than a partial triode circuit giving equivalent results.

You know, I typed "Ultra-Linear" in the foregoing sentence, then crossed it out. I'm getting quite tired of it, as a name!

ABOUT PICKUPS

To change the subject, I have been taken rather severely to task by a reader, whose letter carries the title "Too Hard On Crystal Pickups." I suggest you read it at this stage.

In its original form, the letter mentioned certain specific types of pickup but these references have been deleted. Though we might all like to argue privately about the relative merits of various items, to do so in print is a different matter.

I recall that well known record which describes, amongst other things, a visit to a mock turtle factory.

". . . The things they said to those poor turtles. I mean cruel things; personal things!

For all that, however, the ideas of the writer are clear enough and we can proceed to discuss them.

NO PREJUDICE

In the first place, I can assure J.M.S. that, as a magazine, we have no preconceived prejudice against crystal pickups. Since we do not sell or market components, we can afford to be completely objective in our view — and that's the way we try to be.

It matters little to us whether designers currently favor electromagnetic, electrostatic, photoelectric or piezo-electric principles. Our job is to pick the type which we think will best meet our requirements — and yours — then design an amplifier to go with it.

In point of fact, the fortunes of crystal and magnetic pickups have swung rather violently in recent years.

Before the war, crystals were pretty firmly entrenched as the standard pickup and nearly every amplifier in existence relied on them to provide the right order of bass and treble response.

After the war, however, attention began to turn to lighter weight, high-

TOO HARD ON CRYSTAL PICKUPS

I WISH to buy an argument about crystal pickups. You and your colleagues have for some time been dividing pickups into two distinct classes; moving iron-coil types, suitable for "hi-fi" wide range gear, and crystal pickups suitable for cheap commercial radiograms and cheap, not-so-critical amplifiers.

Hovering uncertainly between these two you (apparently) place one or two odd types which you admit, after a large amount of pruning with various filters, can give moderately "hi-fi" results. The inference from this is that all other crystal pickups are inferior, especially those with turnover heads.

According to many amateur and professional audio men, there is on the local (and Australian) market an imported turnover crystal pickup with "constant velocity characterisation plus or minus 2db to 14kc."

Your article on crystal PUs in the December "Argument" prompted me to make some measurements on this model with gear available at Auckland University. Unfortunately, the only test record available was a rather worn 78 (ED1190).

I was, I must admit, rather disappointed with the result; the output was 13db down at 13kc, rising to 3db down at 10kc, followed by a 4db peak at 6kc after which is dropped to record reference at 2kc and thereafter followed the record down to 50cps and was only 3db down on record reference (ie, —17db in all) at 30cps. Even these figures compare very favorably with the ceramic PU quoted.

I was, of course, not satisfied with this result, and accordingly tested a high quality (and price) PU of known flat response on the same record.

The result will be obvious, or else I wouldn't have written this. It was 13db down at 13kc, 2db down at 10kc and a 5db peak at 6kc. I later found that the record had been extensively played by a number of cheap pickups; apparently a sympathetic frequency record!

The pickup was fed into a resistive load of 120,000 ohms, as recommended by the makers, and while it would not show up quite so well into your ½-meg test load, its excellent characteristics are readily obtained without recourse to complex and inconvenient LC and RC filters.

The output, viewed on a CRO showed no obvious distortion down to 50cps and even at 30cps the trace was substantially sinusoidal. The sapphire stylus wears well and wear was not observable after 60 LP playings under a 25x binocular microscope, nor under a 100x monocular one.

I hope this rather long-winded dissertation will serve to dispel the apparent prejudice in Radio and Hobbies against ALL crystal turnover pickups, and to point out the rather unfair damnation with faint praise you sometimes accord them.

In conclusion, I should like to congratulate R. and H. on an unfailingly interesting magazine, especially the "Serviceman" and the "Argument series".—J.M.S.

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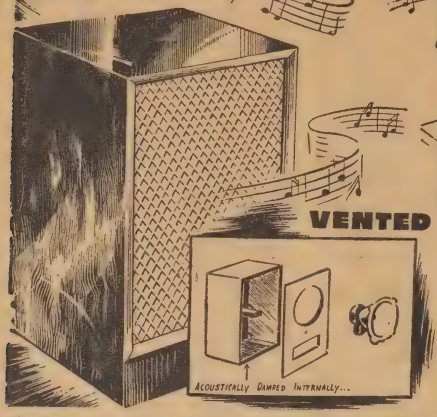

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ompliance and extended fre-
ecy response. Various new mag-
ts appeared on the market and,
r the first time, amplifier fans
class began to worry about com-
rated preamplifiers.
e whole process was vastly ac-
lerated by the appearance of
ongroove records but, unfortun-
e, many of the new magnetic
ups did not live up to their
er's expectations. Suspensions
e, hard or soft, arms got stiff
floppy, styli didn't fit properly,
ups wouldn't track the records
so on.

'STALS AGAIN

ien came the crystals with their
vilever suspension and sapphire
. They didn't suit the new am-
iers quite as well but, at least,
were mechanically reliable. As
sult, they found wide acceptance,
uring the popular market.
rystal pickups are still very firm-
entrenched as a class and are
ky to remain so for a good while
ome. However, where an am-
ier enthusiast is really jealous
is overall response curve, he is
dy to pass the crystals by for one
the later model magnetics.
ow that does not mean that any
netic pickup must automatically
etter than any crystal. Far from

hat it does mean, and what we
e observed in practice is this: If
enthusiast can provide an ampli-
with the necessary gain and
pensation, then he will gener-
get better results from a good
lity magnetic than he will get
n a good quality crystal.
By "magnetic", we refer to mov-
coil, needle armature, moving
or variable reluctance types.)
t is, perhaps, significant that the
st ambitious pickups in the world,
most carefully made—and the
st expensive, of course—use one
ther of the above principles.

SIC REASON

n point of fact, there is a very
d and basic electrical reason why
s should be so. It goes right
k to the mechanics of disc re-
ding.
t has to do with the law which
gests that, for a given sound
rgy, the movement of a dia-
agm varies inversely with fre-
ncy.
ou can see it operating in the
e of a loudspeaker. When re-
ducing low notes, the cone moves
preciably to either side of its
rmal position. At higher frequen-
s, the cone movement is barely
ceptible, even though the acous-
output may appear to be just
loud to the listener.
ff we examine the situation a little
re closely, we discover that the
parent acoustic energy is related
the peak velocity of a diaphragm
other such device.
When it comes to recording on
disc, this variation in amplitude
actually a nuisance, because it
ans that the lower frequency
nds cause progressively greater
splacement of the recording stylus:
ooves have to be spaced out to
event them running into one an-
ner.
When magnetic cutters and pick-
s were introduced, it was found
at, as normally employed, they
eyed the same "velocity" law.
rthermore, because of the wider
equency range they made possible,
they obeyed it more effectively! The variation in amplitude with frequency became a real problem.

As we are all well aware, it led to the adoption of "recording characteristics" designed to restrict the rise in groove amplitude at the lower frequencies. Recording engineers inserted electrical filters into he recording system on the assumption that complementary filters would be used in the playback amplifier.

The practice has persisted, with numerous variations ever since, but here is the important point: All such compensation is regarded as a variation from the basic constant velocity characteristic. It fits in nicely with the natural slope of RC and RL filters and all our ideas of compensation are prejudiced that way.

To the amplifier enthusiast, a "flat" pickup is, therefore, one which delivers an output proportional to peak stylus velocity. Having acquired such a pickup, he then proceeds to modify its output at some suitable point in the amplifier by the use of the aforesaid filters.

This is all very nice for the manufacturers of magnetic type pickups, because they start off with a generator which fits in with current notions and practice. Their job boils down to one of suspending the moving system in a way which will give adequate compliance without growing a resonance peak in the audible range.

The manufacturer of a piezo-electric pickup has to solve these selfsame problems but, in addition, he has another very big one on his hands.

NEW CHARACTERISTIC

If he is going to produce a pickup which is "flat" according to our preconceived notions, then he must somehow modify the natural "amplitude" characteristic of the crystal to a "velocity" characteristic. If it isn't going to be done externally with loads or compensating pads, then it has to be "wangled" mechanically.

Some years ago, I put this selfsame question to a pickup designer. How could he possibly modify the natural law of a piezo-electric generator to produce constant velocity characteristics?

"You have to add compliance," he informed me, "between the stylus tip and the crystal, so that the drive varies inversely with frequency."

Smart enough, but the catch is obvious; It's much harder to design a "flat" pickup when you have to solve two major problems instead of only the one.

And there, I think, is the crux of the whole matter. If you want to produce a pickup with a velocity law, it's much easier to start off with a generator which is fundamentally velocity conscious.

Whether a crystal pickup designer would admit to all this is another matter. I wouldn't be surprised, however, if he doesn't feel that circumstances have cheated him of the final advantage.

The present wholesale restriction on bass amplitude and the use of treble pre-emphasis has brought the modern recording characteristic perilously close to a constant amplitude law. It is so close, in fact, that crystal pickups are adequate and just about ideal for routine domestic use.

If only the recording companies would go — or could go — the extra distance and adopt a true constant amplitude characteristic, then the proponents of piezo-electric generators would be on clover. We'd be able to give away all the fancy preamplifiers, compensators and whatnot.

MAY NEVER COME

But that day may never come. There may be some very good reasons why it shouldn't come. If there weren't, we wouldn't have anything to argue about!

But what of the tests carried out by J.M.S.? Do they really do anything to prove his claim that the crystal pickup in question is really flat? I hardly think so.

To be sure, we're not too keen on the ED1190 disc, as I seem to remember saying some years ago. I have always suspected it of having a wider than optimum groove, which tends to lose a grip on sharp styli and to let natural peaks in the pickup grow to disproportionate size.

However, I have never had any reason to suspect the accuracy of its calibration and I remember having plotted some very good results from it, using a magnetic pickup and a stylus known to be rather over-size.

Our tests are normally carried out with discs other than this one and, once again, I can only say that we have never had any special reason to doubt the accuracy of their calibration. We have taken literally hundreds of curves in recent years and have lifted off the records, using high grade pickups, results flat to within a decibel either way.

We have experimented with mass and damping and watched peaks move up and down the range, changing in size as they did so. We've come to know what to expect from pickups of different type and pattern. We've tested pickups in groups and plotted the curves for different pickups of the same type and batch.

PURELY OBJECTIVE

We had no axe to grind in presenting the curves in our December issue. They were purely an objective comment on the response to be expected from the currently popular cantilever styli crystals.

There is nothing surprising about them. You can trace in them, quite clearly, the effect of load resistance, the constant velocity characteristic of the record around 1Kc. the onset of the treble resonance and the limiting effect of damping.

The pickup which J.M.S. mentions was among those tested and I can only be impressed with the way his findings correspond with our own. I tried to achieve a "constant velocity" characteristic by fiddling with the load but without much success, I'm afraid.

Frankly, I never have been able to obtain such a characteristic simply and accurately from a mass-produced crystal. They all seem to end up with kinks and bends in the wrong place.

The only real mystery is why the pickup "known to be flat" showed the same results.

You know, I'm always mighty suspicious about a pickup which shows peaks in its response curve.

"It would never have done for the Duke, Sir! It would never have done for his Grace!"

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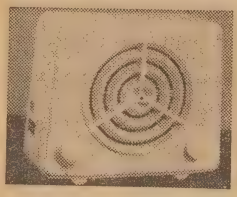

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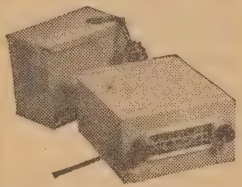

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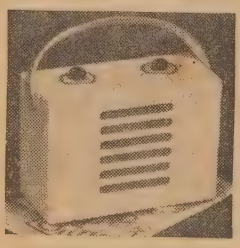

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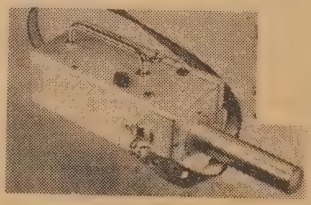

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OFF THE RECORD — NEWS & REVIEWS

Probably the most interesting record I have received this month features the French composer Camille Saint-Saens, known to most people by the "Carnival of the Animals", or at least parts of it, and a piano concerto played sometimes at concerts and frequently by students.

By JOHN MOYLE

BUT his Symphony in C Minor is probably as unfamiliar to most as it was to me until I heard the Philips recording, which has just been released. Maybe it isn't a great work but there is a great deal of good music in it, reams of ingenious orchestration, and a splendidly balanced recording which is a pleasure to hear.

SAINT-SAENS—Symphony No. 3 in C Minor Opus 78, played by the Residency Orchestra, the Hague, conducted by Willem van Otterloo. Philips A00715R.

This symphony was written as part of the composer's attempts to rejuvenate French music with transfusions from contemporaries in particular, and it isn't, therefore, surprising to hear the voices and techniques of so many appearing throughout it.

For instance, a few bars from the beginning one just can't miss the styles of Schubert and Schumann, nor a little later, a page straight from Cesar Franck. Berlioz and Liszt appear in many places, more particularly in the finale.

There are no defined movements. The music goes from one mood to another without a break. The material is restricted, but it is used so inventively that it is never dull. The Gregorian sequentia Dies Irae is the theme which runs throughout and is the main factor in tying it all together.

Saint-Saens was an organist, and included an effective organ obligato in addition to a piano part, using up to four hands. It would be quite impossible to list the various devices which appear but technically, if not intellectually, this is work of no mean order.

The recording is admirable in every way. It is not extremely wide range, but otherwise it is hard to fault. The balance is beautiful. The organ is full but never overpowering. The piano might have been a little more prominent, but one would need to know the music better to form a judgment on such details.

There is a most satisfying body to the sound and a full-bodied bass throughout.

Only two minor growls — your quick ear will pick a couple of tape joins, and you may wonder whether the organ and orchestra are completely in tune, particularly in the finale.

I found the NAB curve best.

BRAHMS—Symphony No. 4 in E Minor Opus 98. Played by the New York Philharmonic-Symphony Orchestra, conducted by Bruno Walter. Philips A01118L.

A very fine recording of the Fourth —it may well be the best we have heard to date.

Its clear competitor is, I think, the Toscanini version which, although I haven't it by me for a direct comparison, remains in my mind as the kind of Brahms I like.

It is quite different in most respects from Bruno Walter's. It has that typical sense of urgency and drive which I always like to hear. Walter plays the first two movements very much slower, shaping each phrase with care under an analytical eye, sometimes at the expense of the longer line which is essential to preserve with Brahms.

But it's only fair to realise that many like it that way.

The last two movements are taken at a brisker pace, and I'm sure you'll appreciate the sudden feeling that the music has come to life after a somewhat over-nostalgi beginning.

The recording, however, woul probably score somewhat over the of Toscanini, at least until the las movement in which, particularly o wide range equipment, it degenerate somewhat under pressure, possibl due to the mechanics of productio

This appears to have been anti cipated in the recording for th volume level has been reduce noticeably in the last bars. On th other hand the quieter passages ar always clear and each instrumen stands out in good balance.

The second movement appealed t me as being the best. It contain some really beautiful playing.

The surface has a very quiet his which will probably be picked u by your tweeter, although there ar very few surface clicks or othe blemishes.

In summary I would say this is one which cannot be passed over when selecting the best available, and until we are lucky enough to strike one which has the virtues of all those so far issued, might well be your choice. After all, records of this calibre are few and far between. The original was an American Columbia. It plays best with EMI setting.

TCHAIKOWSKY — Capriccio Italien, Opus 45; Liszt—Les Preludes, Symphonic Poem. Played by the Philharmonia Orchestra, conducted by Alceo Galliera. Columbia 33-OSX-1013.

Another record by the same team which recorded the "Romeo and Juliet" recently released with such success.

This record is a mate to it in general approach and in recording standard. The Philharmonia has apparently worked out a formula which can be relied upon to produce clean, safe and successful records, and while it couples universal favorites such as these on a single disc it is assured of a ready sale for them.

I was very much impressed with the general balance of both discs, which combines a weight and breadth of the full orchestra with the ability for single instruments to be heard clearly. There is if anything a little too much reverberation, but it does add to the impression of size which is essential for work like this.

And yet neither side achieves as much brilliance and bite as I felt they could have done with very little alteration to things. Both these works have very solid climaxes and sound peaks which it is perfectly permissible to exploit. I had the feeling that punches were being pulled a trifle when they could have scored on the button with telling effect. Those cymbals — why not have brought them a foot or two nearer and let them rip? I think the customers would have liked it.

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IBELIUS — Symphony No. D major Opus 43. Played by London Symphony Orches- conducted by Anthony Col- . Decca LXTA2815.

ce more Anthony carries off the 's for a Sibelius record, for I ot know a better version than ne.

re is a Radiola-Telefunken by Tor Mann and the Stock- Concert Society Orchestra I liked very much when ed, but this new Decca ink is to be preferred. a much more forward record- although there are portions e there is not very much to e between them.

m a technical point of view is quite a symphony, particu- in the final movement where are long periods of heavy cut- to be done and dangers to be ed with heavy orchestration. t, despite the fact that it has released for nearly two years, still a very good recording. will never hear this symphony like the record when listening concert hall, unless maybe you able to suspend yourself in and the public eye alongside microphone.

ose powerfully plucked basses the incredible blasts from the in the last movement would come to you with such power e normal way of listening.

t that I would place it in the top bracket, for there is a in woolliness at times in the and more than a hint of con- n in heavy passages. The would probably have sounded effective with a little more r from a greater distance, but impressive work for all that, all-in-all it will take some ng.

aring more of Anthony Col- gives me the idea that he is apt e a little extreme in his re- ns both dynamically and in o, and this sometimes gives a trical tinge which spoils the rally authoritative air of his . I feel that Beecham, his t Sibelius predecessor, would shaped things a little better. On other hand his interpretation is niably a fine one, and I can oughly recommend it.

e surface noise isn't above re- ch, but it is normally rendered dible by the high level record-

KHACHATURIAN — Concerto r Piano and Orchestra. Played the Residency-Orchestra the gue conducted by Willem van lterloo. Philips A00708R.

ery few people now find this erto hard to comprehend, for ite its modern idiom and varied hms it is based on an almost sical concerto form, cadenzas and

fact there is a simplicity and ct appeal about its melody and tment which could make it an remely popular middle-weight cert piece. Despite their great iety, the rhythms are well de- d, and not at all strange to the tern followers of advanced jazz. fact, such a one might even con- r some passages rather corny!

fancy Winifred Atwell might have nd it more to her size than the eg, although no one without rior motive would wish such a ilishly difficult piano part on to body.

This was one which Kapell played with such breathtaking speed and precision. Yuri Boukoff doesn't manage quite as much high-speed clarity, but makes up for it in flexibility. Kapell rarely unbent with an effect more intimate than the flexing of high-powered steel.

There is no comparison between the old Kapell recording and this one, so it's not much good being nostalgic. Here we have the best type of Philips work, and probably their best recording orchestra as well.

The fine quality and balance are similar to those of the Saint-Saens Symphony. Surface noise is virtually absent. Sounds first class with EMI or NAB playback curve.

SCHUBERT—Sonata in B flat major (Post); Sonata in A minor Opus 143. Played by Friedrich Wuhrer (piano). Vox PL8210.

Two Schubert sonatas of this quality on one disc make a very tempting proposition for any music lover, particularly when one of them is the B flat major, generally considered to be Schubert's best.

It was the last of his piano pieces and has a maturity quite clearly in advance of many earlier works, including the A minor on the reverse side.

Not that his song-like music isn't predominant. There is probably no better example of a song arranged for the piano than the opening of the B flat sonata. But as the movement is developed there is a much greater-than-usual variety and technical imagination to be heard which is unmistakably the result of added maturity.

Friedrich Wuhrer combines sensitivity and restraint to produce quite an outstanding performance—perhaps a little aloof at times, for Schubert was essentially warm-hearted, but always beautifully controlled and immensely satisfying.

It is only too easy to exaggerate the song writer in Schubert, and lose altogether the size and shape of his wider view. This is particularly true of the posthumous B flat, as opposed to some of the Impromptus, for instance, where such treatment would be more in character.

The recording is good, a very firm piano tone with ample weight and tone in the loud passages, all of which come through cleanly and with no sign of a break.

Unfortunately there is some surface hiss which extends far enough down the scale to be audible in softer passages, and even a faint hum from the tape which wide range machines may pick up.

These however are minor points which otherwise would bring this disc into the very front bracket.

Only Schnabel, who gave us so many wonderful Schubert records, would head this performance, but as I have remarked before there is little point in looking so far backward.

LALO — Symphonie Espagnole Opus 21. Played by Campoli and the London Philharmonic Orchestra conducted by Eduard van Beinum. Decca LXTA2801.

This is Lalo's best-known work, and probably his most successful. It has the true Spanish air about it, tender, gay and characteristically rhythmical.

Campoli is just right as soloist As the chief figure in the scoring, his violin over-rides the orchestra without being obtrusive, for the entire music is written around its voice. Occasionally, it grows a little edgy, but Campoli inclines that way.

This recording includes the third movement which is often left out in concert performances. In truth the work is rendered more compact by this practice, but on disc there is every reason why we should have it in its entirety.

Decca's recording is bright and with good range. Even on the Decca setting, with its comparatively light top cut, there is little surface noise to be heard.

Can be safely recommended.

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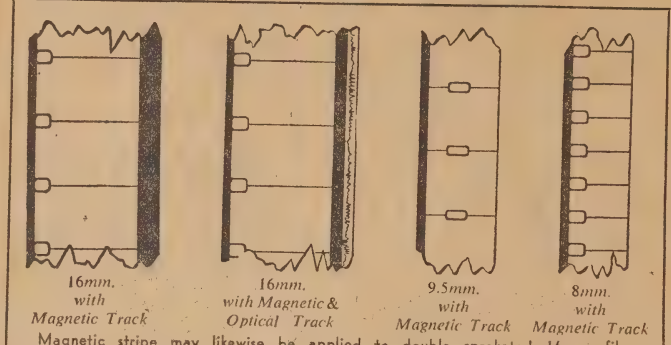

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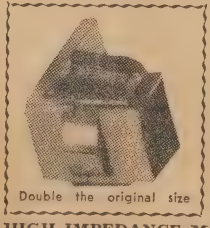

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In assessing a disc of this nature, ne must regard it in the light of its ntention, which is a matter of usical record as much as a perrmance intended for a steady diet. his I think applies to these records f early organ music more than to ny others, and we have had a umber of valuable examples from ifferent studios in recent months.

On this count we find a selection ating from the middle of the sixenth century to the eighteenth. Apropriately they are played on the t. Jans Church organ, which was uilt in the 1730's, by a distinguished rganist who has made a special tudy of this music. Add an exeptionally clear and clean recordng, and you have the story of this isc.

I found it played best with an AB setting, and even a little extra op cut if you have a wide range et-up, for although the registration f the organ is exceptionally bright, t does sound somewhat piercing in eproduction.

On the other hand this was a haracteristic of such organs, and t would probably sound more in roportion when the higher registers were diffused throughout the buildng which has a nave 370ft long.

The organ action is faintly heard n the background, and there is some ape noise as well. But the surface s very clean.

Frankly I found it a beautiful piece of work, and if you are interested in this kind of music I'm sure you'll agree that it is a fine record.

TCHAIKOWSKY — Symphony No. 2 in C minor Opus 17. Played by the Royal Philharmonic Orchestra conducted by Sir Thomas Beecham. Philips AO1130L.

We must, I fear, admit that Tchaikowsky's first two symphonies have neither the appeal nor the quality of those which came later on.

They are formative without a doubt, and it is interesting to see in them the seeds which germinated and came to life in the titanic work which followed them.

But in themselves they lack a cohesion and core. They leave us unsatisfied—tuneful and at times interesting musical expressions which often come to nothing.

Only in the last movement do we hear anything of the drive and power characteristic of the later symphonies.

However, leaving aside personal opinions of musical worth, it is unlikely that you will hear a much better Second for a long time, because not only are recordings of this work few and far between but this one technically is almost faultless.

Certainly there are few difficulties to be met with, but all the same it has a particularly good balance and clarity with a completely silent background.

The instrumental definition is splendid. In the last movement, the contrast between cymbals and the weight of a bass drum illustrates what I mean.

I hope we can look forward to all these good things applied to better material in the future.

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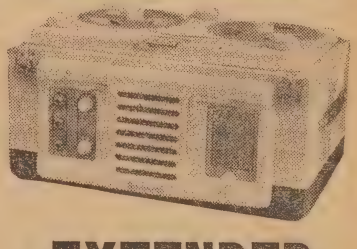

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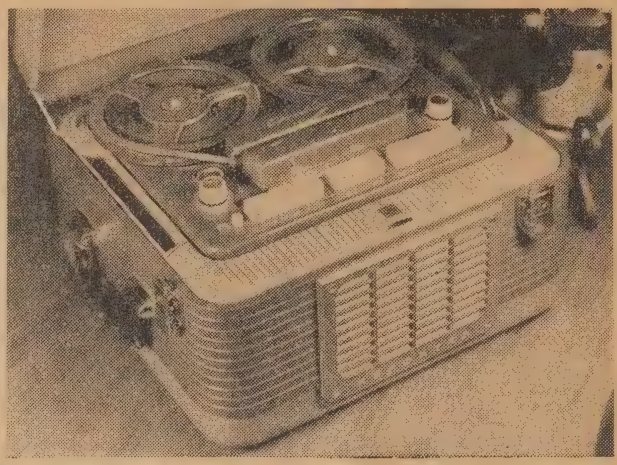

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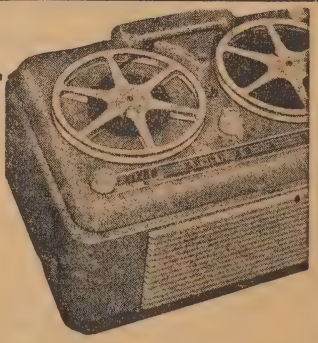

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● As you will see we have advertised a super tape recorder for only 94 guineas, really the best I have ever seen for the money, does everything the big ones do.

That's all I have room for, folks. Call in and see our new showrooms and say a few words.

Peter Clark

Nothing but Tape Recorders

BRUCKNER — Mass in E Minor by the Chorus and Orchestra of the Hamburg State Opera conducted by Max Thurn. Radiola-Telefunken LSK7029.

The strength of this recording, I ould say, lies in the performance. lthough I haven't heard it before, is not hard to appreciate some ne singing and choral work, though at times the tempo seems drag a little.

But the recording isn't up to odern standards. It is quite re- ote, and although the reverbera- on allows a somewhat ethereal end between orchestra and choir, ere is very little definition to ther. I doubt whether I heard single sibilant in the whole thing. is recorded at rather a low level, o, and some of the louder pas- ges are not clean.

I think you had better judge this ne for yourself.

VIVALDI—Concerto Grosso in D linor. Mozart—Divertimento in D ajor K251. Played by the Dum- arton Oaks Chamber Orchestra led Alexander Schneider. Mercury G10002.

Mercury have made things tough r themselves here. The studio is uite a dead one, the range is very ide, and it's just as well there re no heavy breathers among the layers, for I'm sure we would have eard them too.

As a result, there is virtually no everberation at all, and I found it ounded best when listening well way from the speakers to give the eproduction a little more air. Play- d that way, with fairly high vol- me, the realism at times was quite emarkable.

Whether everyone will like the nfiltered violin tone I don't know, ecause most of us are used to earing it with some of its charac- eristic edge removed. But with is disc we get the lot.

The intention was to present the usic with a small group as it might ave been played originally. The erformers are all good, and their rive never falters. It is quite re- entless, perhaps a little too much o.

The music is fairly well known nd delightful to hear.

The recording curve is given on he envelope together with other etails. Nevertheless I found the AB curve to be best. At low olume some bass reinforcement ight be preferred.

There is a noticeable difference n balance between some of the ovements and a very slight tape um to be heard.

THE IMMORTAL WORKS OF ETELBY—played by the New ymphony Orchestra conducted by tanford Robinson. Decca LXA4080.

Ketelby's musical pictures are too ell known to require much com- ent. With the appearance of "In Monastery Garden" during World Var I his reputation was made, and he music made regular appear- nces for sentimental scenes in silent lms, in which capacity I first heard t.

Since then more tuneful and ometimes brilliantly written pieces n similar vein have appeared, and pparently have an everlasting ppeal.

There are nine of them on this ecord, including "Bells Across the Meadow", "Persian Market", "Sanctuary of the Heart" and the "Chinese Temple Garden".

The performance and the recording are first rate. All the essential color is there, and the frequency range is extremely good. It may not be everyone's choice, but if you have nostalgic memories of the music, you aren't likely to hear it better played or recorded, and all on one disc.

Of its kind, full marks.

GIPSY VIOLINS—Antal Kocze and his Band (six numbers) Westminster WL3008.

This is one of a series of gipsy music recordings by Antal Kocze, who is an acknowledged master of the art.

The technique is for the violinist to take the tune, and for the members of his band to improvise on broad lines in the accompaniment, in a way which modern swing bands imagine they have invented.

I think you either detest or love Gipsy music. Whether you do or not, the recording here is a typical wide-range Westminster, with a silent surface and a forward, vivid tone you could cut with a knife (or vice-versa) in the full Hungarian tradition. There just isn't any surface noise.

BRAHMS.—Fantasies Opus 116; Four Pieces Opus 119 for piano. Played by Wilhelm Kempff. Decca LXTA 2935.

You will almost certainly recognise some of the pieces which are often played separately. They include three capriccios, seven intermezzos and a rhapsody.

Kempff has recorded a good deal of Brahms and all of it is first-class. This record must be considered one of his most successful.

Not everybody can play these things. They were the last piano music Brahms wrote, and contain some fine music. There are seven pieces in Opus 116 and four in Opus 119, and they show Brahms in every mood—ponderous, passionate, strong, ruminative, gay and tender. It's so easy to get lost in some of them.

But not Kempff. The more I hear of his latest records the greater respect I have for him. He has so many of the things that go to make a master pianist, not the least of which is that fund of imagination and judgment and perfect control of head and hands.

If anything, he errs at times on the heavy side—The E flat major Rhapsody is generally taken faster and with more vigor.

The piano sounds very well. The microphone placement I thought just about right for the occasion, the tone has plenty of warmth and body and is quite free from any signs of pressure.

Apart from a few minor swishing noises which come and go during the Opus 116 the surface contributes little more than a rustle. Played quietly when you are suitably in the mood, this is a lovely record.

DOHNANYI—Variations on a Nursery Song; RACHMANINOFF—Rhapsody on a Theme by Paganine. Played by Julius Katchen and the London Philharmonic Orchestra conducted by Sir Adrian Boult. Decca LXTA2862.

The coupling of these two is rather a strange combination, for, however generous we may be toward it, the

(Continued on Page 112)

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URTHER THOUGHTS ON FIDELITY

It is a long time since we have seen radiograms being advertised and sold under the tag of "high fidelity", but in recent months there have been quite a few of them. Others are contemplated, and it is safe to assume that by the end of the year every major manufacturer, and others as well, will enter the lists.

OW, that is all very well in its way. Any move to produce bet- radiograms will be welcomed ost heartily by yours truly, nor uld I willingly do or say any- ng which would discourage the actice or injure any honest at- npt.

But, alas!—it is human nature to sten on to a term intended to iden- y the highest degree of perform- ce, and, in the enthusiasm of the ttle for sales, apply it to practic- y everything in an endeavor to tch the consumer's eye.

Somebody—it may well have been lls-Ryce, who could be pardoned it—once decided that they had a ne" car. What a word! Visions exclusive excellence, of the pro- cts growing under craftsmen's nds, of the distinction ownership ve to those who paid their money, the neighbors' envy, and the vis- e evidence of one's own good judg- nt and taste!

But look around. Nearly every car lay is "fine", even the slickest pro- cts of mass-production. And, in fairness, no one could describe e modern assembly-line worker as craftsman.

Have we suddenly become blessed th an unbelievable improvement manufacture, or does the word ne" mean something different to- y?

Perhaps it does. Perhaps we can ve a fine car as a cheap line just we have one in the upper bracket. aybe it is a fine car—for the price. aybe that's the answer, but it does the word of any absolute value ich once it possessed.

But that isn't the effect the ad- rtisements are meant to have upon ur judgment. The man who wrote em still wants you to believe that product has "fineness", whereas competitors' has not, even though sells for the same price and might ve come from the same factory d use many of the same parts.

AME REASONING

I think the same reasoning can be plied to the wide use of the term igh fidelity" all over the world to- y. It is meant to convey the im- ession of extreme excellence, of ods which, when referred to the t possible standards, measure up them. It is meant to distinguish em from those of good but lesser ality, and still further from those average or poor performance ich might be expected to sell for s.

But only recently I saw an adver- ement in an overseas magazine for "high-fidelity" table record-player ich had no more chance of meas- ing up to high standards than I ve of being Prime Minister. And the very next page the same label as attached to a luxurious-looking rn-out which, by its description, ght well have been accurately med.

The truth is that there are certain ndards more or less accepted by gineers as to what constitutes high fidelity. Those who are honest find difficulty in defining absolute fidelity, and don't hesitate to say so. But it's much easier to set down in measures of distortion and so on targets which must be reached before the words have real meaning.

It is easy to be cynical about these things, and to believe that no one takes any notice of advertisements, anyhow. The manufacturers selling radiograms so labelled would be most indignant if you were to accuse them of—well, exaggeration.

The same thing is true of record manufacturers, of course. Today a great many of them are "high fidelity" in the publicity sheets, but in truth very few are good enough to deserve the description. Certainly, most of them sound well, but even the average ear finds no trouble in recognising the dazzling quality of the true high-fidelity record, no matter how pleasant others may sound.

Even the significance of the words in the eyes of those who use them has changed. My observation leads me to believe that anything which has more than average high-frequency response is frequently accepted as high fidelity. The even response and freedom from peaks which must go with good sound are cheerfully passed by.

WHAT'S TO DO?

I'll wager that, before long, users of such equipment will once again reach for the top cut filter knob in an endeavor to achieve a better balance, just as they did in the old days.

Well, what's to do? as my grandfather used to say. Do we abandon the term to the beguiling artifices of the copy-writers and their little verbal games, or do we try to build some meaning back in the words themselves?

One advertiser, again from overseas, at least has made an attempt. He says, in effect, that the term means so little these days that he won't use it. His product merely has "fidelity", which, by implication, is probably intended to convey that he and his readers accept the pleasant fiction of the other thing and that, confidentially, his product is better than any of them.

I'm afraid that, once any catchphrase has been taken into popular use with a lowered significance, there is little hope for it. That being so, it seems logical to believe that the public will not pay any real attention to the tag, and pick the product which sounds best, anyhow. It all seems so futile, doesn't it?

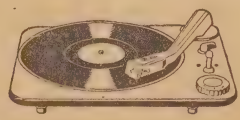
It may also mean that makers of top-grade equipment will abandon the term as having any real value, and win their battles on figures of performance. Even if these cannot tell you how good it needs to be to be indistinguishable from its competitors, they will at least provide some more accurate definition of performance which was originally implied in the term "high fidelity".

Dual

For all THREE speeds

DUAL Recordchangers and players are the most advanced models available in Australia today. Masterpieces of engineering, their flawless reproduction ranges from 20 cps. — 15,000 cps. Recordchanger 1002F will change 10 MIXED 10in and 12in records and 10 7in records **with large centreholes.** Changers and players may also be used manually and 7in centre inserts are **supplied free** with each unit.

DUAL Changer Model 1002/F complete with NORMAL and LARGE CENTRESPINDLES.
PRICE (Sydney) **£35/12/6**



DUAL 3/Speed player chassis 275 complete with 3 position scratch filter, already mounted on springs.
PRICE (Sydney) **£19/10/6**

Available from better dealers everywhere.

DUAL Recordplayers and Changers are marketed and serviced by

FRED A. FALK & CO. PTY. LTD.
28 King Street, Rockdale, N.S.W.
Telegrams: GRAMOFALK.
PHONE: LX 4783.

Agents in all States

SHORT-WAVE NOTES BY ART CUSHEN

LATIN AMERICANS SHOW UP EARLY

Strong signals from many 19 and 25 metre stations in the early afternoons are a sure sign of winter reception.

SIGNALS from Chile are being heard consistently in the 25 metre band, and four stations are being heard with consistently good signals. CE1174 "Emisora Nuevo Mundo" operates on 11740 Kc as the call of the Chilian station suggests. This manner of identification is used by all Chilian stations, O being added to the call to get the frequency. CE1174 has been heard to sign off at 3pm following a sports broadcast from Santiago with games between teams from Argentina and Chile.

A network of stations in six countries was announced, relays of the sports being carried by stations in Peru, Ecuador, Paraguay, Argentina, Uruguay, and a large network of Chilian stations.

Emisora Nuevo Mundo recently confirmed our reception of their medium wave station CB93 with a very cordial letter from Snr. Joaquin Blaya Barrios, Casilla 6009, Santiago, Chile, who also enclosed a very fine pennant, and we presume listeners would receive the same type of verification from CE1174.

CE1190, which for many years has operated on 11900 Kc has now been heard on 11935 Kc and we presume the change was made to get clear of the interference of HCJB on 11915 Kc with 100Kw. CE1190 has been closing at 2.15 pm and uses the well-known "Land of Hope and Glory" as a signature tune, the slogan of the station is, "Radio Co-operativa Vitalicia".

On 1195 is the slightly weaker signal of the Radio Society of Mineral transmitter, which operates in chain with CE822 on 6220 Kc. On 11980 Kc is the strongest signal, that of CE1198, operated by the Society of Agriculture, at Santiago and relays the broadcast band station CB57. It will be noted that most of these stations are operated by Co-operative societies in Chile.

The best Santiago signal on 19 metres is CE1515 operated by the Radio and Television Santiago and using that slogan. The use of 15150 Kc gives good signals here to closing at 2 pm.

Some time ago CE1515 verified our reception with an excellent pennant, one of the finest we have received, and we are pleased to learn that several New Zealand listeners have recently received pennants after some months of seemingly non-verifying.

BRAZILIANS ON 19 METRES

"Radio Panamericana" in Sao Paulo is the slogan used by PRB23 operating on 15135 Kc. It generally closes at 12.30 pm but when sports are carried sign off is later. Though Radio Record controls this station they do not relay their medium wave broadcasts but rather the newer Panamericana station which they also control.

Sao Paulo is also the home of another newcomer, this is Radio Nacional, which appears to be government controlled, as is the namesake in Rio de Janeiro. No call-sign is used and the station signs off on 15170 Kc at 1 pm. Interference is apparent from All India Radio in Delhi using 15160 Kc. PRL7 on 9720 Kc the Radio Nacional Rio de Janeiro has an English recording to sign off at 2 pm.

Other South Americans which are providing good signals include the Radio del Estado station LRA operated by the Argentine Government at Buenos Aires and heard on 9690 kilocycles. The station has been heard with a classical program to 12.55 pm, then a news broadcast in Spanish is presented and the station signs off at 1 pm, with a march.

The Government Radio of Peru using 9565 Kc has excellent signals at 2 pm and closes at 3 pm. Two missionary broadcasters heard to 3 pm are TIFC San Jose in Costa Rica on 9645 Kc and TGNA on 9665 Kc located in Guatemala City, but interference from the Brisbane transmitter on 9660 Kc often makes clear reception difficult.

GUATEMALA'S TGWA on 9760 Kc has a special transmission in English on Sundays from 3.30 to 4.00 pm and at the conclusion of the broadcasts a request is made for reports to National Radio TGWA, Guatemala City. As well as on 9760 Kc TGWB on 6180 Kc also carries this English transmission. TGWA operates 10.35 pm to 4.00 pm daily, and on Sunday the sign-on is at 11.55 pm to sign-off at 3.00 pm on Monday.

A new station has been reported from Swedish listeners using the slogan "Radio Crystal de Guatemala" on 11756 Kcs at 1.20 pm to 2.00 pm TGTA "Radio Bolivar" on 6355 Kc gives a new slogan and address in their broadcasts and the station is now known as "Radio Sonora" and the address is now 6a Avenida 14, 35 Apatado 401, Guatemala City, Guatemala.

RADIO AUSTRALIA DX SESSION

THE popular DX session over Radio Australia is now broadcast at the following times and frequencies.

2.00 pm .. .. .. 15200 Kc.
3.20 pm .. .. .. 15200 Kc.
5.00 pm .. 7280-9850 Kc.
11.30 pm .. .. .. 9615 Kc.

AFTER several weeks of reports from European listeners that they were hearing test transmissions, the new Austrian transmitter has at last been heard here on 11935 Kc. The station is using a 4000 watt transmitter located at Linz-Kronstorff and is using the frequencies of 5985, 7245, 9665 and 11935 Kc.

The complete schedule enables reception here at 5 pm on 5985 and at 3 pm on Sundays on 11935. Though the 9665 Kc channel is good at 7 am, reception of the station is not possible due to the use of the frequency by the Swiss Broadcasting Corporation at Berne, in their transmissions to the United Kingdom and Portugal.

THE VOICE OF AMERICA

THE sign-on announcement of the Voice of America has been given a new style. Instead of the former short transmitter sign-on as previously, a long descriptive announcement is broadcast. This gives the aims and purposes of the VOA and with it goes a request for letters about the programs and its contents, with a request for reception reports from listeners. The address for reports is now Washington 25, District of Colombia, USA. The highest frequency at present used by VOA is 21630 Kc and this transmitter KCBR—1 is operating 8.45 to 11 am, with broadcasts to the Far East with a news broadcast at 9.30 am.

BBC MONITORING SERVICE

THE technique of intercepting and porting foreign broadcasts has gressively developed since the BBC co-operation with the then Ministry Information, started a listening uni August 1938 in the justified anticip that many of the more normal r channels would soon disappear — reports the BBC Handbook.

The experience gained during and the war proved that this is a rapid unique means of gathering news. governments throughout the world since found that it is essential to m tain such a service. The service con of three main parts, the receiving tion, the news section and the trans tion service which records the mate

Part of the information gathere supplied to newspapers in the Un Kingdom on a subscription basis.

NOTES from readers for next issu should be sent to 212 Earn St Invercargill, NZ. All times are Eas ern Australian Standard.

During the past year the main work the Monitoring Service has been gathering of news from behind the Curtain, and the compiling of off statements and comment from this a Generally this is the first and o only means of gathering such news it At the same time broadcasts from o parts of the world, in particular Middle East, have often given the news of any internal crisis, as well giving a picture of the changing in national scene.

The monitoring of broadcasts from parts of the world with a view to obt ing late news and firsthand news f foreign countries must be the clo occupation to our hobby of Dxing.

Established in 1938 the BBC's Moni ing Service is located in Tatsfield Surrey and, at the receiving stat broadcasts ammounting to 120,000 wo daily from 44 countries, and in 34 guages is monitored. In order to get details of broadcasts in the Far E the BBC exchange information with American counterpart as the signals f Asia are often below standard in United Kingdom.

A day never passes that we do hear some news announcer state "Cairo Radio said . . ." such and su showing that the monitoring service been in action in the news search.

FLASHES FROM EVERYWHERE

MADAGASCAR'S 90 metre outlet been heard at good strength by Rex lett, of Adelaide till the sign-off at am. Rex lists the frequency as 3200 and the program heard was of popu music. The station uses the identifica of "Ici Tannarive" when closing tra missions.

The broadcasts are heard in South A tralia from 4.30 to 5.30 am sign off, strength has been at times fairly stro Tannarive is seldom heard in New Z land, and listeners in West Austra have often reported good signals fr this area when signals fail to reach teners in the Eastern States, who anxious to hear Africa, the hardest the continents to be heard with any liable broadcasts.

THE HAM BANDS WITH BILL MOORE

Changes in operating techniques often present problems to radio amateurs. The introduction of VFO's on the VHF's is at the moment the subject of much discussion overseas.

late 1954 the VFO made its first appearance on the 144 Mc band in at Britain. Since then much com- at both for and against the innovation been voiced and printed on the sub-

he general consensus of opinion ears to be against the introduction VFO's to these frequencies. Here are e of the points raised:

he facility of stations being able to e around the band destroys the value he known fixed positions where DX ons appear, and eliminates the use- ess of the spot calibration of estab- ed receivers.

many cases VFO users have oper- on the frequency of crystal con- ed DX stations and stop any chance ontact for local stations.

uite often the offending station could hear the DX station, audible only in ricted areas due to narrow ducting. offset the above is the ability of users to change frequency and so inate QRM at times.

OMPLEX QUESTION

he whole question is accepted as a complex one, and in view of the lihood of an extension of VFO oper- h it is suggested that an endeavor made to reconcile the various points view before the band becomes un- able.

will be remembered that a Zone n for 144 Mc is generally accepted Great Britain.

tations in various sections of the ntry use different segments of the d and provided the plan is enforced VFO users do not wander all over band some control can be exercised.

he problem of VFO operation in this ntry has not arisen as yet, although subject has been discussed.

2AIW UHF correspondent for the GB's bulletin suggests an early inves- tion into VFO operation.

he main object to eliminate the etition of the useless habit of stack- stations on the one frequency sing the DX station, common on the s.

ome excellent openings have occurred n the UK to Europe on 144 Mc. G6NB ing one session contacted 3-DL's, N4's, 2-PAO's and 17-F's, with no ort under S7.

IFFER EXAMS

n the US, since the previously re- cted telephony band segments were own open to general an dconditional ss licences, the examinations were fened to include more technical ques- ns on telephony.

ome typical questions may be of in- est for an examination allowing some vileges to our own AOCP, they are as ows:

What are the undesirable effects of r modulation in radiotelephony?

What are the relative bandwidths of be A1 and A3 emissions, of single- eband and double-sideband ampli- e-modulated emissions?

What is the formula for calculating the ctance of a capacitor?

What is the formula for determining characteristic impedance of an air- ulated parallel conductor transmission e?

n a series-resonant circuit, if the ue of inductance is kept constant. at must be done to the value of the pacitance to double the resonant fre- ency?

Draw a schematic diagram of a high- s filter with constant-K pi section anced type.

Draw a schematic diagram of an RF wer amplifier stage using parallel d.

Draw a schematic diagram of a Colpitts oscillator circuit.

What does the Q of a circuit have on harmonic output?

What is the reciprocal of resistance?

What is skin effect?

What is the Q of a resonant circuit?

How may the shock hazard from high voltage condensers after the power supply is turned off be reduced?

QSL BUREAUS

The following list of QSL Bureaus covers Canada, USA and her territories They are run by the individual amateurs on behalf of the ARRL, the league covering expenses involved.

Cards for any of the prefixes listed can be sent direct to addresses shown.

W1, K1—J. R. Baker jun, W1JOJ, Box 232, Ipswich, Mass.

W2, K2—H. W. Yahnel, W2SN, Lake Av., Helmetta, NJ.

W3, K3—Jesse Bieberman, W3KT, Box 34, Philadelphia 5, Penna.

W4, K4—Thomas M. Moss, W4HYW. Box 644, Municipal Airport Branch, Atlanta, Ga.

W5, K5—Oren B. Gambill, W5WI, 2514 N. Jarrison, Tulsa 6, Okla.

W6, K6—Horace R. Greer. W6TI, 414 Fairmount St., Oakland, Calif.

W7, K7—Mary Ann Tatro, W7FWR, 513 N. Central, Olympia, Wash.

W8, K8—Walter E. Musgrave, W8NGW, 1294 E 188th St., Cleveland 10, Ohio.

W9, K9—John F. Schneider, W9CFT, 311 W. Ross Av., Wausau, Wisc

W0, K0—Alva A. Smith, W0DMA, 238 East Main St., Caledonia, Minn.

VE1—L. J. Fader, VE1FQ, 125 Henry St., Halifax, NS.

VE2—Austin A. W. Smith, VE2UW, 6164 Jeanne Mance, Montreal 8, Que.

VE3—W. Bert Knowles, VE3QB, Lanark, Ont.

VE4—Len Cuff, VE4LC, 286 Rutland St., St. James, Man.

VE5—Fred Ward. VE5OP, 899 Connaught Av., Moose Jaw, Sask.

VE6—W R. Savage, VE6EO, 329 15th St., North Lethbridge, Alta.

VE7—H. R. Hough, VE7HR, 2316 Trent St., Victoria, BC.

VO—Ernest Ash, VO1A, PO Box 8, St. John's, Newfoundland.

KP4—E. W. Mayer, KP4KD, Box 1061, San Juan, Puerto Rico.

KH6—Andy H. Fuchikami, KH6BA, 2543 Namauu Drive, Honolulu, Hawaii.

KL7—Box 73, Douglas, Alaska.

KZ5—Gilbert C. Foster, KZ5GF, Box 407, Balboa, Canal Zone.

The above addresses, together with the list published in the March issue, complete the full complement of the world's QSL Bureaus.

EMERGENCY WORK

Future emergency operation by radio amateurs in NSW will undoubtedly follow lines similar to those of the February-March floods. Before this emergency a set of suggestions had been drawn up by the NSW Division of the WIA, and it was along these lines, as guided by VK2WI, that amateurs were to operate.

There was only one variation. It was not anticipated that so much traffic would be handled by amateur stations and that so many channels would be required.

The whole scheme worked well and left amateurs to operate as units rather than to be absorbed in the channels of other services, where in the past little credit has been given. With so much traffic arriving via VK2WI, the authorities receiving this traffic were well aware that it was coming through WIA CDEN nets handled exclusively by amateur stations.

Incidentally Gordon McLeod, VK2ADC, of Beverly Hills, ran the 3.5 Mc leg of the VK2WI net during the recent floods, his transmitter operating practically continuously for two weeks. He was assisted by many amateurs. He covered country areas with a consistent signal and was referred to as VK2AD previously.

VK2WI played an extremely important part, providing valuable control and liaison, and it is certain that the official station will be even more useful in future emergencies.

Some of the original suggestions included the following:

The first action of an amateur in an emergency area is to advise VK2WI that an emergency is developing and that he is about to offer his services to the local police. Ring MU1092 or MU1879 for VK2WI. VK2WI will transmit on 7050 and or 3525 KCs and if necessary VK2AWX station of the Hunter branch will operate.

Stations in areas adjacent to the emergency are requested to report in to VK2WI and stand-by in case assistance is required.

Stations in the Sydney metropolitan area if hearing an emergency call should advise VK2WI by telephone. The main object is to ensure that amateurs obtain the right publicity and do the most effective work in any emergency.

On the subject of publicity given in the Press to amateurs during the last emergency, many amateurs were disappointed with the details presented. It has always been difficult to obtain space but on this last occasion the total exceeded that given previously for similar work.

The Postmaster-General, Mr. Anthony, in a Press release announced the proposed establishment of a complete radio net between post offices in areas likely to be flooded.

In view of previous experience and despite official links there still should be plenty of work in the emergency for amateurs in the field.

In the Hunter Valley the VHF Flood Warning link put into operation some time ago was considered by many to be able to carry any information required by officials at Maitland and other towns down the valley.

SUDDEN CALL

Amateurs in the valley who accepted the publicity for the link on its face value were dismayed to find their services were urgently required and to date had not kept their mobile/portable equipment serviceable.

They were soon on the air when flood waters subsided and they returned home, but during the height of the flood important traffic could have been handled with portable equipment. There will be communication work, at least for a long time yet, for amateur stations during serious flooding of NSW towns.

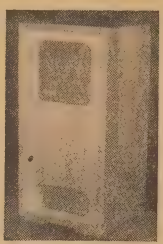
Additional information has come to hand on the radio efforts of technicians who placed a transmitter on the 3.5 Mc from the Maitland Post Office (West Maitland).

Bob Best, VK2TY, supplied the transmitter and originally set it up to be used if the necessity arose. Bob was also to supply a SW receiver but on checking some radio equipment at the court house was marooned there for 36 hours. The only receiver at the exchange was a small BC set.

The Maitland-Newcastle-Sydney line held up right throughout the floods, and by that means VK2WI acted as a listening point for the Maitland exchange transmitter.

The station was finally used as a 3.5 Mc link to the TX site of Broadcast Station 2NX where the late Keith Rud-

MOTOR SPARES LTD



BASS REFLEX CABINETS

Built from 1-inch solid timber with ¾-inch ply front panel. Adjustable vent to match the cone resonance of your 12-inch speaker. Supplied polished in silver ash colouring for £17/5/-, Plus sales tax. Unpolished for £16/2/6, Plus sales tax.

Kit of parts, all timber cut to size and ready to assemble, also grill material baffle board, etc., Price £12/10/-, plus sales tax.

Wooden Speaker Boxes covered with heavy leatherette, Fawn, Brown, Green, Blue colours available.

Size for 12-inch speaker 37/6
Size for 8-inch speaker 27/6
Size for 6-inch speaker 25/-

CATHODE RAY TUBES

Cathode Ray Tubes, all new and boxed.

5BP1, 5-inch Electrostatic Deflection, ... £2/10/-

VCR97, 6-inch Electrostatic Deflection, ... £2/19/6

5API, 5-inch Electromagnetic Deflection, £1/19/6

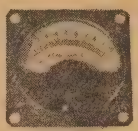
5FP7, 5-inch Electromagnetic Deflection with socket, housing, deflecting coils and controls, £3/10/-.

Transmitting Tubes. All new and boxed. 100 TH Eimac 100 watt triode, 39/6 ea. CV92, 4C27 Triode, indirectly heated, filament, 6 volt at 6¾ amps, anode voltage 6000. Maximum frequency 750 Mc/s. Amplification factor 29, Plate dissipation 125 watts, **19/6 each.**

LOG DIALS

Log Dials as illustrated. These are similar to the Philips log dial and can be calibrated by the home constructor for whatever instrument or equipment he is making. Positive, smooth friction drive. Two scales provided with each dial.

Price only 14/6.



METERS

0-1mA Meters 2in scale, square face as illustrated. Ideal for building multimeters, 1000 ohms per volt, 100 ohms internal resistance. Brand new and boxed.

Price only 32/6.

With multimeter scale, 37/6.

0-20 mA Meters, 2½-inch scale, 3¼ overall diameter. **Price 39/6.**

0-300 volt DC, 2½-inch scale, 3¼ overall diameter, meters. **Price 39/6.**

0-100 volt AC, 2-inch scale square face. Each has an 0-1 mA DC movement and a 1 mA full-wave meter rectifier included. Worth £6.

Our price, 45/- ea.

50 mA DC Meter, square face, 2-inch scale. Good condition. **19/6 ea.**

0-200 micro-amp meter, 2½-inch scale, 3 3-16 diameter overall.

A few only, 47/6 ea.

0-30 volt meters, Weston, new. A few only, 2-inch scale, black scale with white, luminous lettering.

25/- ea.

SPECIALS

1. **Record Changers.** Reconditioned Single Speed Record Changers, guaranteed in working order. Well known makes: Garrard, Collaro, H.M.V., Stromberg Carlson, Plessey. **Price only £5 ea.**
2. **Single Speed Motors** with pick-up and automatic stop. Reconditioning guaranteed in working order. **Price only £2/17/6 ea.**
3. **Round Dial Transfers.** Ideal for small radios, etc. Diameter 2½ inches. Marked in Kilocycles. Colours: Gold, Red and Black. Very attractive. **Price only 6d ea.**
4. **German Diodes.** Ideal for detectors in crystal sets, also for rectifiers in meters and radio sets. **Price only 4/11 ea.**
5. **Tubular Suppressor Condensers.** 0.1 x 0.1 x .01 mfd 2250 volts. Ideal for Vacuum Cleaners, Floor Polishers, etc. **Only 1/- each.**
6. **Miniature Chokes.** Iron cored chokes, size 2in x 1¼in x 1 3/16in overall, suitable for Geiger counter. **Only 3/6 ea.**
7. **Amphenol Ceramic Octal Sockets.** Excellent for high frequency and high voltage work. Worth 5/- ea. **Our price 2/6 ea.**
8. **Iron Cored.** R.F. Coils BC Shielded High Gain. Well known make, brand new and boxed. Worth 11/6. **Our price 2/3.**
9. **30 Henry 60ma Filter Chokes.** Brand new. Worth 25/-. **Our price 14/6 ea.**
10. **Spring Gramophone Motors.** This excellent wind-up motor is suitable for replacement in portable gramophones, etc. Complete with turntable and fittings. **Price £3/10/- ea.**
11. **3 Speed Gramophone Motors** to operate off 230 volt AC supply with speed change control knob. Suitable for playing both standard and microgroove recordings. Brand new and excellent quality. Worth £8/10/-. **Our price £5/10/-.**
12. **3 Speed Gramophone Motors** with high fidelity turnover crystal pick-up and automatic stop. Well known make. Brand new and boxed. Worth £12/15/-. **Our price £8/19/6.**
13. High Fi, Hi-G turnover crystal pick-ups. Well known English make. **Price £3/15/- ea.**
14. **Carbon Microphones.** Hand type with switch in bakelite case. **Price 5/6 ea.**
15. **Resin Cored Solder.** 1lb reels 16 gauge. Worth 17/- lb. **Our price 9/6 lb.**
16. **250 ohm 25 Watt Rheostats.** Wire wound on mica with porcelain insulation. **Price 4/6 ea.**
17. **Padder Condensers** to suit 455 KC oscillator circuits, adjustable. Worth 2/9. **Our price 1/3.**
18. **Cosmocord Crystal Pick-up Cartridges,** complete with needle screw. Suitable for replacement in most crystal pick-ups. Worth 32/6. **Our price 7/6.**
19. **Low Impedance Headphones.** British manufacture, new & boxed. **Price 18/6 pr.**
20. **High Impedance Headphones.** German manufactured 4000 ohms impedance phones adjustable for maximum output and efficiency, light weight fitted with cord and plug. Ideal for crystal sets and most other purposes. Weight 1½lb. Worth £4/10/-. **Our price 39/6.**
21. **AT5 Transmitters.** In good condition with valves Frequency coverage 140 KC to 20 MC/S. Provision for 6 crystals. Valves used 2-6V6 and 3-807. Weight 32lb. **Price only £7/10/-.**

SPECIAL NOTICE

All parcels sent Registered Post unless otherwise stated. Postage or Freight must be included with order.

547 ELIZABETH ST., MELBOURNE ALSO AT — ALBURY ARARAT BAIRNSDALE BALLARAT BENALLA BENDIGO BROKEN HILL COLAC DANDENONG ECHUCA SALE FRANKSTON GEELONG MILDURA SHEPPARTON ST. ARNAUD WAGGA WANGARATTA WARRAGUL

, VK2DG, operated and the B/C re-
ver at the exchange completed the
ss-band contact.
he transmitter was moved at one
ge and technician, Ray Robinson,
iembered enough of army training to
e it up successfully.
he link operated for over 48 hours
sing valuable information for relief,
the technicians in their first venture
amateur radio provided an essential
vice.
Harold Whyte, VK2AHA, who jour-
ed to Maitland, operated from East
itland which was completely isolated
til some AWA FM transceivers arrived
m Newcastle. They operated on 80
s.

RUNGA CONVENTION

The NSW Division's North Coast and
blelands Convention held at Urunga is
progress at the time of writing. The
ge attendance included amateurs from
3 and VK4.
Judging from the comment of the many
otable/mobile stations active from the
trict the event was as popular and
well supported as on previous occa-
ns.
Visiting amateurs included VK2AHA,
T, 2ACU, 2YC, 2AAB, 2ARY, 4PR, 2EA,
I, 2AKI, 3DU, 2PA, 3ID, 3ALQ, 2SR,
E, 2AVG, 2AVS, 2AUI, 2FH, 4TN, 4PP,
XZ, 2AHH, 2ACD, 2ASW, 2WQ, 2AWG,
PB, 2ABT, 2ABP, 2YK, 2AJF, 2AMV,
C, 2APS, 2ADN, 2ASA, plus many
ves, associate members and junior
erators.
Doug Bowie, VK3DU, Federal secre-
y of the WIA was in attendance, and
e visit will be of great value in pro-
ding direct contact between the State
visions and the Federal executive.
The Sunday morning VK2WI broadcast
as presented from Urunga via
K2ASA's transmitter by State presi-
ent Jim Corbin, VK2YC.
Next year's executive for the conven-
on was elected. The members are as
llows: Patron Crieff Retallick, VK2XO;
ce presidents, Noel Hanson, VK2AHH,
d Jack Gerard, VK2ADN; secretary,
lan Williams, VK2FH; treasurer, Ted
abriel, VK2AVG; organiser, Peter
lexander, VK2PA; liaison officer, Syd-
y, Ted Whiting, VK2ACD.
The Gerry Challender Memorial Trophy
ntest run on 7 Mcs was won by Don
llard, VK2ASW, zone officer Noel
anson, VK2AHH, in second place, and
eter Alexander, VK2PA, third.

SILENT KEY

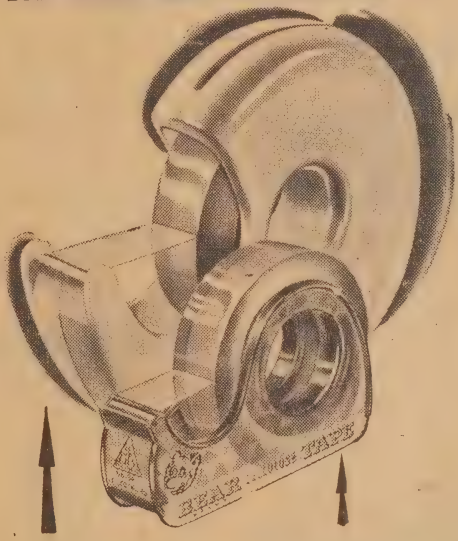
It is with deep regret the sudden
assing on March 13 of Keith Rudkin,
K2DG, of Maitland, is recorded.
Keith, a broadcast station engineer at
NX, north of Maitland, had operated
or days on end, often without assist-
nce, from the transmitter site during
he devastating floods in the Hunter
alley.
The station using emergency power
as operated practically continuously
nd Keith had little sleep for many days
hile he passed messages covering flood
arnings and relief for local residents.
He had not previously been ill and
is considered that the strain of this
ork contributed directly to his un-
imely death at the early age of 44 years.
Keith was perhaps best known in
mateur radio for his extensive DX work
n the 14 Mc band. He built up a very
ine record in this sphere and was an
rdent supporter of the VK/ZL DX con-
tests. Postwar he won the 14 Mc section
f the test on a number of occasions.
The deepest sympathy of all amateurs
s extended to his wife and family.

DX NOTES

Around the equinox European stations
were at excellent strength just before
unset and at sunrise on the 7 Mc band.
Oud Charman, G6CJ, well-known an-
tenna specialist, was running S7 at times.
The W stations around the long way
on 7 Mc at 0700 hours East were S7 at
times. The introduction of compact
7 Mc rotary beams have improved DX
working on this band and in many cases
are replacing the popular ground plane
antennas.
The first weekend of the CW section
of the W/VE DX contest was not well
supported here due essentially to the
extensive emergency work by NSW
amateurs. Stations that normally would
have operated kept off the air to assist
the net operation. Conditions were only
fair on 3.5 and 14 Mc band but quite
good on 7 Mcs.
The second weekend saw some excel-
lent 3.5 Mc signals. The band a mass of
W signals up to S8, with JA's, KH6's,
KP's and YV's also audible.
During the previous week only an
odd W station could be heard at the
same times. DX working on the band
would reach all time records if we could
only influence amateurs in the Americas
to operate in the small hours. It takes
a contest to work up sufficient enthusiasm
to rise at such unnatural times.
John Gore, VK1PG, of Heard Island,
returned to Sydney in April and is
active again as VK2PG, using the same
equipment that performed so well from
the island. John has now completed two
sessions down south, the first in 1950-51
the second 1954-55.
Schwinger L. Vinzenz, ex OE1VL,
points out that the initials covering the
Austrian QSL Bureau should read
OVSV not DVSV as shown in the March
issue. The address is correctly listed.
The QSL manager is Willy Blascheck,
OE1WB, well-known old-timer who used
to sign OE3WB. He was the first to
contact China and Japan from Europe.
OE1VL operated from 1946 to 1951 and
is anxious to meet VK amateurs, his
address Whyalla, SMQ, C5, SA.

BEAR TAPE

is the original cellulose tape made in Australia for Australian conditions

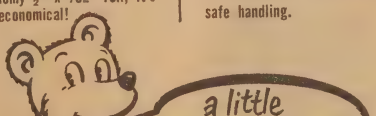


PLASTIC HAND DISPENSER

If you use large quantities of sticky tape in your home, use a "Bear Tape" Plastic Hand Dispenser with the economy ½" x 792" roll; it's so economical!

BRIGHT UTILITY DISPENSER

½" x 200" roll in bright dispenser at 1/6 is Australia's best buy, and it's plastic for safe handling.



"BEAR TAPE" is by far the biggest selling tape in Australia

MADE BY BEHR-MANNING (AUST.) PTY. LTD., ALSO THE LARGEST MAKERS IN THE SOUTHERN HEMISPHERE OF HIGH QUALITY SANDPAPERS, PRESSURE SENSITIVE TAPES AND "PROOFKOTE"

LD4a

SURPLUS

512 Elizabeth St., Melbourne, C1.

Phone: FJ5904. Just 4 doo

Mail Orders Carefully Packed

Please add Freight or Postage

At last the spotlight you have been waiting for

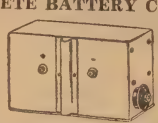
Fitted with genuine American sealed beam globes. No motorist or boat owner should be without one.

Ideal for Fox or Rabbit Shooting

6 Volt, 70/-; 12 Volt, 76/-. Fitted with Switch and Flex.

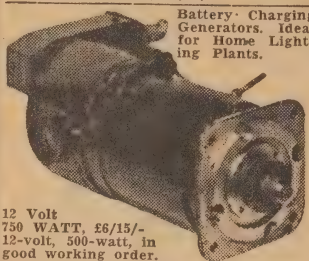
COMPLETE BATTERY CHARGER

Fitted with Brand New English Selenium Rectifier.



Works off 230v. Household Supply.

Charges any battery, 6 volts at 4 amps, £6/15/- complete. Also available, 6 or 12 volt Charger combined. Charge 3 amps. £7/15/-. Brand new 6 volt, 3 amp. Chargers, complete, £5/10/-.

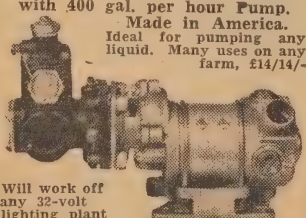


Battery Charging Generators. Ideal for Home Lighting Plants.

12 Volt 750 WATT, £6/15/-
12-volt, 500-watt, in good working order. £7
12-volt 500 watt new, £7
24-volt, 1000-watt, Brand new .. £8/10/-

200 amp Generator. Ideal for welding. Made in America. Brand new £50
Tested and in perfect order .. £35

Aircraft 24 volt Motor complete with 400 gal. per hour Pump. Made in America.



Ideal for pumping any liquid. Many uses on any farm, £14/14/-

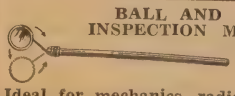
Will work off any 32-volt lighting plant

Pump only, 55/-

AMERICAN VACUUM or AIR PUMP

Builds up air pressure to 20lb at 1000 R.P.M. develops up to 120lb of hydraulic pressure; will pump 7½ gallons S.A.E. oil or other liquids per minute. Useful for spraying, milking, presses, oil burners, hydraulic systems, £3/10/-.

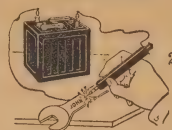
BALL AND SOCKET INSPECTION MIRRORS



8/9

Ideal for mechanics, radio repairs

ELECTRIC ENGRAVER



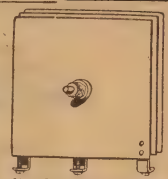
29/6

Works off any car battery. Engrave your name on all your tools.

Not secondhand.

BRAND NEW ENGLISH G.E.C. RECTIFIERS

Make yourself a Battery Charger.
12v. 2 amp. 32/6
6v. 6 amp. 49/6
12v. 3 amp. 45/-
6v. 2 amp. 24/6
6v. 4 amp. 45/-
12v. 5 amps 79/6



Transformers to suit above Rectifiers. 2 amp, 37/6; 6 volt, 5 amp, 45/-; 12 volt, 5 amp, 55/-.

ARMY SPOTTING TELESCOPES

Many uses on the farm. Ideal for Sheep Spotting.

Useful on the rifle range, 3 draw 17in long, 6½in closed, 1in object lens, 18 magnification. Made in England .. **£7/19/6**

ARMY FOCUSING TELESCOPE

Easily converted for use on dumpy levels. Can be used as a rifle sight. Excellent magnification .. £4/19/6

Fitted with cross hair.

ADJUSTABLE FOCUS

BRAND NEW STUDENTS' MICROSCOPES

Not a toy. A real Microscope.

Hours of enjoyment for any boy or girl Student.

300 magnifications.

84/-

Test slide included in nice box.

R.A.F. LEATHER FLYING HELMETS, 35/- each

Intercommunication Tubes 50/-.

MK7 Goggles, 37/6 Pair.
MK8 Goggles, 48/6

Polaroid Goggles, 48/6.

WOOL LINED FLYING BOOTS, £5/15/- pr.

WATCHMAKERS AND INSTRUMENT MAKERS

English Tweezers .. .. .. 6/6 and 5/6
Eyeglasses .. .. 6/6 aid 8/6
Extra strong double lens Eyeglasses 15/-
Screwdrivers, set of five 13/9

SPECIAL DISPOSALS METER OFFER

0-3 amp mete AC-DC, 2½in di 45

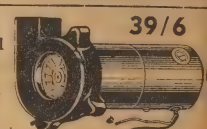
0/1 milliamp, 2½in dial .. 37
Weston 0-50 vo
0-100 amps cor bined M/coil, £3/10

English 50-0-50 Ammeters, M/coil 37
English 0-50 Ammeters, AC-DC .. 42
English 0-40 Voltmeter, M/Coil .. 25
English 0-300 AC-DC Voltmeters .. 55
English 0-5 Milliammeters, 2½in .. 27
English 0-25 Ammeters, 2½in M/c .. 30
English 0-10 Ammeters, 2½in dial, Moving Coil 45
English 0-30 Voltmeters, 2½in dial, AC-DC 42
English 0-40 Ammeters, 2½in dial, A-DC 42
English 0-30 Ammeters, 2½in dial, AC-DC 45
English 0-150 Voltmeter, 3in dial, Moving Coil 39
Eng. 0-500 Micro Ammeter, M/Coil 37
Eng. 0-20 amps, 2in dial, M/c. .. 25
Eng. 0-1½ Milliamps, 2in dial, M/c. 19
Eng. 0-20 Milliamps, 2½in dial, AC-DC, 20-0-20. 17
Eng. 20-020 Ammeter, M/Coil .. 37
Eng. 0-30 Amps AC-DC 2½in dial 42
Eng. 0-50 Amps AC-DC 3½in dial 75
Eng. 0-60 Amps AC-DC 3½in dial 75
Eng. 0-80 Amps AC-DC 3½in dial 75
Eng. 0-1 Amps DC 2½in dial .. 35
Eng. 0-5 Amps AC-DC 2½in dial .. 45
Eng. 200 Amps AC-DC 3½in .. £4/19

Brand new AEROPLANE WHEELS
IDEAL FOR WHEELBARROWS, HAND TRUCKS, TRAILERS, etc.

10½in x 4½in £4/15/-, complete with tube

English Motor and Blower, 24 volts.



39/6

Will work off any Lighting Plant.

Large size also available that wil work off 12 or 24 volts, £3/15/-

Now you can make your own musi box with these Swiss music units They can be fitted to any type of box doll, jug, teddy bears, etc. Hours o enjoyment for all the family.

30/-

EACH

Tunes available, Lili Marlene, Jingl Bells, Blue Danube, Harry Lim Theme, Wedding March, The Merr Widow, Happy Birthday, Anne Laurie How Dry We Are, Roll Out The Barrel Silent Night, Teddy Bears' Picnic. Also available a few only double unit which play 2 tunes, 50/- each.

Miniature Music Units fit cigarette case Ladys' Compact etc., 39/6, also 230 vol Music Unit works continuously, 59/6

STORES

512 Elizabeth St., Melbourne, C1.
om Victoria Street. Phone FJ5904
and Efficiently Despatched
Include State in Address

IN FIRST-CLASS ORDER DALTON COMPUTERS IDEAL FOR AERO CLUB, 45/-

66in wide waterproof canvas 15/- yd. Fish-pond aerators, work off 230 volts, 57/6. Officer type Blackboots, 42/-.

LUCKY REPURCHASE ENGLISH SMITH 8 DAY CLOCKS

: used the AF.

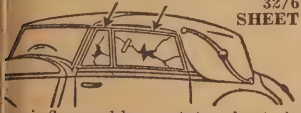
Luminous Dial.

£5/15/-

itted with Sweep Second Hand. Ideal for any car or truck.

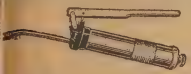
eplace those broken side curtains ith cellulose acetate which takes e place of celluloid and lasts four nes longer. Will not discolor.

32/6 SHEET



on-inflammable acetate sheet is ecommended for all types of side urtains. Sheets are 20 thousandths 1 inch thick. Size of sheet, 24in 52in. Can be sewn or cemented to frames.

BRAND NEW LEVER TYPE GREASE GUNS WORTH £4/19/6



59/6

Ideal for all types of Trucks. Tractors or Cars. 7500lb pressure.

Brand new American Wobble Pump, semi-rotary.

PHOSPHOR BRONZE VANES

Continuous low, £3/19/6.

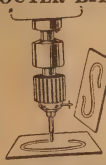
Ideal for caravans, emptying or filling petrol tanks, watertanks, etc.

ENGLISH ARMY SPOTLIGHTS

IDEAL FOR FIT ONE TO YOUR CAR.
6-volt 37/6.
12-volt 25/-.

Fitted with Mirror Reflector.

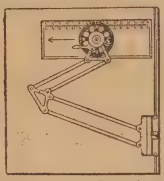
ROUTER BITS



Ex-Munitions. Cost 18/6. Our Price 10/- each.

Can be used on Metal or Wood.

AIR FORCE PLOTTING BOARD

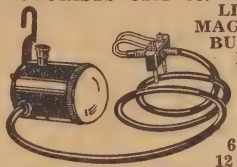


Ideal for use as Students' drawing board

25/- Complete

Complete with Drawing Arm

MOTORISTS' CLIP ON TROUBLE LIGHT, MAGNIFIED BULL-EYE LENS



6 Volt 7/6
12 Volt 6/6

Complete with flex and plug.

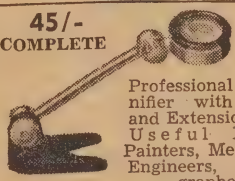
24-VOLT MOTOR COMPLETE With Fuel Pump

Ideal for Caravans. Takes the place of Hand Pumps.

£5 each.

Many uses on the Farm. Will Transfer Petrol or any Liquid from Drums, etc. Will work from 24 or 32 volts AC or DC.

45/- COMPLETE



Professional Magnifier with Stand and Extension Arm. Useful Doctors, Painters, Mechanics, Engineers, Photographers.

Spray YOUR CAR, TOYS, HOBBIES, FURNITURE

52/6

Spray from your Spare Tyre.

An ideal Tool for touching up damaged paintwork

Will spray Lacquer, Paint, Enamel.

RAAF VARIABLE RHEOSTATS

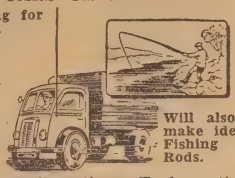
2 OHMS 100 WATTS IDEAL FOR BATTERY CHARGERS.

15/- EACH

Ideal for control of motors, Electric Trains, Lights, etc.

STEEL ARMY TANK AERIAL RODS WILL MAKE IDEAL RADIO AERIALS FOR CARS OR TRUCKS

Too long for postage. Advise nearest railway station.



Bases to suit Aerials, 12/6 each.

Will also make ideal Fishing Rods.

12ft long, 3 sections. Each section 4ft, **22/6.** 8ft long, 2 sections, **15/-**

SPECIAL OFFERS FROM OUR NEW MOTOR ACCESSORY DEPARTMENT

American Schrader tyre pumps, work from your spark plugs, **39/6.** Car type fire extinguisher. Every car should carry one. Cost £7/10/-, **£4/10/-.** Steel mechanic's tool boxes, **19/6.** Brand new 7/8in spark plugs, suit most old type cars, **2/6,** or ideal for tractors. S.A.E. or Whit Spanner Sets, open one end, ring the other. 6 spanners to set, **23/6.** Army steel tow ropes, looped ends, **17/6.** S.A.E. open end spanners, 6 to set, **24/6.** Whitworth, 4 to set, **18/6.** Whit socket sets, **13/6** set. Mudguard type rear view mirrors, **16/6.** Inside car rear view mirrors, **4/11.** S.A.E. socket sets, **15/-.** Stick on type ash trays, **4/-.** Engineer's pliers, **4/6.** Car jacks, **37/6.** Tyre levers, **3/10** each. Hydraulic 2-ton jacks, **£4/15/-.** 6 volt windscreen wipers, **£4/12/6.** 12 volt, **£4/19/6.** Car pumps, **14/-.** 4½in saw blades complete with arbor, ideal for making saw bench with electric drill, **25/-.** Bell-ringing generators, ideal for telephones, **25/-.** German Army marching compasses, work similar to prismatic, **29/6.** 110 volt 1000 watt projector globes, **32/6.** ¼in Black and Decker 230 volt electric drills, **£11/15/-.** ½in, **£24/8/3.** magnifying Glasses, 8 mags., **8/6.** 10 magnifications, **12/6.** 24 volt motor and hydraulic pump, capacity 3½ gals. per minute, **£3/15/-.** New headphones suitable for crystal sets, **17/6 pair.** New Army Mosquito nets, ideal camping, **27/6.** Genuine RAAF Berets, **10/6.** Tapped Transformers, 6, 12, 18 and 24 volts, 3 amps, **39/6.** 230 volts input. Brand new American Cutting and Welding Torches, **£4/4/-,** complete. Army Slouch Hats in good order, **15/-. Generator Test** Meters, 35-0-35 amp meters, 4½in dial, **45/-.** 0-10 volt meters, 4½in dial, **45/-.** Loading Resistors can be supplied to make meter read 10.20 at **12/6.** Medical Scalpels. many uses, photographers, etc., **6/6.** 4in Shifting Spanners, **6/9.** 6in, **8/-,** 8in, **10/-,** 10in, **11/-,** 12in, **18/6.** Metric Socket Sets, **59/6,** complete with bar.

LIQUID SHUT OFF VALVES

Will work off 12 or 14 volt, ideal for Water or Alcohol Injectors.

50/-

Can be used as Petrol shut off for car protection. Many factory uses.

96 OXFORD STREET SYDNEY

MAIL ORDER, BOX 22, P.O., OXFORD ST.

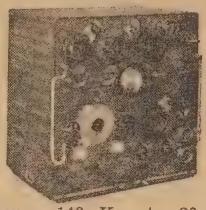
WALTHAM TRADING CO.

319-321 SWANSTON ST 383 FLINDERS ST. MELBOURNE

MAIL ORDER BOX 5234B P.O., MELBOURNE.

In our extensive range of Government Ex-service equipment we may have the very article for which you are searching, obtainable at a fraction of the original cost.
If you are unable to make a personal call, write us your specific requirements, or write for a copy of our latest catalogue.

AT5 TRANSMITTERS



Frequency 140 Kcs to 20 Megs. Containing: — 3 — 807; 2 — 6V6 Valves, transmitting condenser and many other useful components.

Price £4/19/6

ROTARY CONVERTERS

Use standard electrical equipment wherever you are. This Converter will give you 230 volt AC from a 24 volt DC supply. Ideal for equipment using up to 85 watts.

PRICE: 24/32 volt DC .. **£10/19/6**
12 volt DC .. **£14/19/6**

TANK WHIP AERIALS

Ideally suitable for car or truck Aerials. Made from highly tempered spring steel; Tubular and Tapered.

Three 4ft sections, American made, with screw type ends, brand new,

35/- Per Set

English slotted type, three sections,

22/6 Per Set

Packing and Freight, all States 5/- extra.

REFLECTOR ASSEMBLY

4 inch plated reflector mounted on sliding base with adjustable lamp holder and forward mounting bracket. Suitable for use with projectors or enlargers.

Price 35/-

Postage and Packing: 5/-. Interstate 6/-.

BURKE GENERATORS

Hand crank Motor Generator. American made. Type GN-35. Can be used to operate as a 6 to 12 volt electric motor without alteration. Final drive through reduction gear 200 r.p.m. drawing 5 amps approx. Ideally suitable as driving motor for trawling in small boats on rivers or lakes, duck shooting, etc. Generator rating output—10 volts at 1.25 amps; 400 volts at .07 amps.

Price £2/10/-

RADIO RECEIVERS

Type BC-357-L. American made. Suitable for conversion to a super regenerative high frequency Receiver. Frequency 90 Megacycles. Containing: 1—12SQ7; 1—12C8 Valves, one radio control type Relay 10,000 Ohms and many other useful components.

PRICE: £3/10/-. Complete with Relay.

35/-, Less Relay.

Postage and Packing: 5/-. Interstate 6/6.

"PALEC" Valve & Circuit Testers

Ohm range up to 10 megs. 10-100-250-1000 volt AC or DC on FSD.

Price £20/19/6

VERNIER DIALS

Slow-motion Micro Action Dials. Black finish. Size 6 inch diameter. Fitted with quick action release knob.

Price 25/-

Postage and Packing: 4/-. Interstate 5/-.

RECTIFIERS

Make your own battery charger.

24v 3 amp half wave **45/-**
12v 6 amp full wave **50/-**
12v 5 amp full wave **50/-**

"MORSE" BUZZER SETS

Consisting of buzzer and lamp. Fitted into compact wooden box, dimensions: 8in x 5in x 2in. Can be operated by Morse Key from two torch batteries. Ideal for Scout Troops and amateur radio enthusiasts.

Price 19/6

Complete with key.

Postage and Packing: 3/-. Interstate 4/-.

A.W.A. TRANSMITTING CONDENSERS

25 pf to 375 pf.

Price 15/6

Postage and Packing: 4/6. Interstate 6/-.

TRANSPARENT PLASTIC SHEET

Du Pont "PLASTACELE"

Latest Shipment from U.S.A.

This **CELLULOSE ACETATE SHEET** made by **DU PONT**—America's leading **PLASTIC** Manufacturers, is the result of extensive war-time research and experiment, and was specially designed for use in combat aircraft where a light, flexible, durable material was essential.

Non-inflammable—Rigid, yet pliable—Transparent—and far superior to any other type of Plastic Sheet manufactured.

Can be easily **CUT—FORMED—SOLVENT BONDED — LAMINATED.**

Use it for models, picture frames, hobbies, window display, motor cycle windshields, motor car side screens, caravans and in pleasure craft.

100 and 1 uses in the Plastic Industry.

SIZE	PRICE
25in x 21in x .5mm approx.	1/64in, 15/6
25in x 21in x 1.0mm approx.	3/64in, 27/6
25in x 21in x 1.5mm approx.	1/16in, 32/6
25in x 21in x 2.0mm approx.	5/64in, 35/-
25in x 21in x 2.5mm approx.	3/32in, 39/6
25in x 21in x 4.0mm approx.	5/32in, 42/6
25in x 21in x 5.0mm approx.	3/16in, 45/-
50in x 21in x .5mm approx.	1/64in, 31/-
50in x 21in x 1.0mm approx.	3/64in, 55/-
50in x 21in x 1.5mm approx.	1/16in, 65/-
50in x 21in x 2.0mm approx.	5/64in, 70/-
50in x 21in x 2.5mm approx.	3/32in, 79/-
50in x 21in x 4.0mm approx.	5/32in, 85/-
50in x 21in x 5.0mm approx.	3/16in, 90/-

AT5/AR8 POWER SUPPLIES

24 volt. Output—550 volt 350 mil., and 250 volt at 100 mil.

Price £2/19/6

LIGHTWEIGHT (WET) BATTERIES

JUST THE THING FOR MODEL AEROPLANES, and many other purposes where a lightweight Battery is required, 2 volt 20 amp hours (as illustrated on right). Made by Exide. In bakelite case, dimensions 7 ins x 3 ins x 2½ ins. Weight 4 lbs.

Three for 30/-

Packing 5/-.

AN F.M. PLAYMASTER TUNER

(Continued from Page 39)

e as an aerial, it is far better erect a proper resonant aerial it from the start. This will vide a much stronger signal and will have a better chance of ing the station, even if the ier stages happen to be off reso- ce.

simple di-pole may be made mounting two metal rods hori- tally and end to end with about spacing between them. The ier connects to these two inner s and the assembly should be cted broadside on to the station. 92.1 Mc the length of each will be 30.5in.

OHM FEEDER

he impedance at the centre will approximately 72 ohms and der having this impedance should used to connect the aerial to set. This may be in the form co-ax, such as PT1M, or twin der, such as Telcon K20. We se this latter because it is con- erably cheaper than co-ax and es a balanced line to the receiver.

t is simply two solid conductors a plastic covering and spaced to e the required impedance. It is as flexible as co-ax, but will nd reasonable handling and, e installed, should need no fur- r attention.

In difficult localities the efficiency the aerial can be increased con- erably by the use of a reflector. is is simply another rod about per cent longer than the total gth of those in the di-pole and unted behind the aerial relative the station. In this case an erall length of 66in is required d it should be spaced 33in from e di-pole.

Erect the aerial as high as pos- ble, run the feeder by the short- t feasible route, connect it to the ner, and you are ready to start oking for the station. Set the ning capacitor at the mid position d adjust the oscillator trimmer er its full range. Assuming that u have made the coils carefully u should soon find the station, but n't be disappointed if it sounds etty terrible at this stage.

F ALIGNMENT

First thing is to get the aerial nd RF stages aligned, which can e done fairly accurately by ear, articularly if the strength of the gnal can be reduced by temporar- y lowering or rotating the aerial. more accurate method is to easure the cathode current of one f the IF valves, adjusting for mini- um current as controlled by the VC voltage.

A useful signal is normally avail- ble from the transmitter for about ve or 10 minutes each day just efore the program comes on the ir at 11 am. This is simply a 00 cps tone and which may be sed, in conjunction with an output eter, to give a final touch up to he IF channel, RF and aerial cir- uits, &c.

In the past the Sydney station as been observed to broadcast a frequency run at 9 am on Monday mornings. However, this is not entirely regular and seems to have been missed out of late.

So far we have said nothing about the capacitor between the mixer and oscillator grids, and which controls the amount of oscillator voltage injected into the mixer. In fact, the set will work without this component, there being enough coupling between the two triode sections to provide some injection.

While this will be enough to get the set going it is not optimum and the sensitivity will be increased considerably when more injection is provided. The optimum amount is that which gives maximum gain without danger of oscillator pulling, squeeging, mixer oscillation, &c.

In our case we used two short lengths of hookup wire, one soldered to each grid pin, and laying side by side across the socket. We simply adjusted them by closing them up to the required spacing.

DETECTOR CHECK

Having set this correctly, you may turn your attention to the ratio detector again. A weak signal is helpful here also and it may be achieved by moving the aerial as above or by coupling the feeder into the RF coil with a temporary two-turn loop.

This will probably increase the noise level somewhat, a factor which can be quite helpful. Adjust the slug for minimum distortion and also minimum noise, which two settings should coincide. Repeat the procedure with the trimmer and go over the two adjustments several times aiming at minimum noise level. At the same time the primary trimmer must be kept adjusted for maximum gain.

Now tune slowly across the station. If all is properly balanced you should be able to observe three distinct peaks, one weak and distorted to one side, a strong clear one in the centre, and another weak distorted one on the other side. Ideally, the two weak ones should be identical in spacing and amplitude.

A possible simplification of the receiver is to dispense with the RF stage. In locations relatively close to the transmitter (West St., North Sydney) and where an efficient aerial can be erected, the set will work quite well with only a tuned circuit in the mixer grid. In fact, we conducted our first experiments on the tuner before the RF stage was added and obtained good results even with an inefficient aerial.

However, we had to consider the requirements of those who are located in much less favorable areas than our laboratory and where an RF stage would be virtually essential. Hence its inclusion as a standard feature.

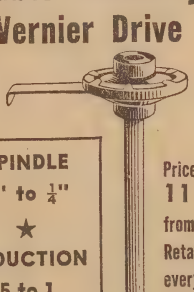
AVC SYSTEM

Another modification which might be justified in some circumstances concerns the AVC system. Ratio detectors are prone to distortion at high signal levels and there may be a risk of overload if a set with an RF stage is used in close proximity to the transmitter.

The modification is quite simple, but increases the effectiveness of the system by removing the voltage divider network. It consists of eliminating the 2.2 meg. resistor and substituting the 4.7 meg. in its place.

However, whether you modify it or not you should find this a very interesting and instructive project and one which will give you a very good tuner. Used on the best program material it is capable of a really impressive performance and which is very difficult to achieve by ordinary methods of reception.

Jabel Planetary Vernier Drive



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RECORD REVIEWS

(Continued from Page 101)

Dohnanyi is in, neither the same class nor mood of the Rachmaninoff; as recorded here it would seem that the performers thought so, too; for I didn't feel that they were very interested in it, despite the genuine brilliance of Julius Katchen, undoubtedly one of the most competent keyboard virtuosi among quite a collection of first-class performers recording at the present time.

The Rachmaninoff, on the other hand, has an entirely different air, as though Sir Adrian had said, "Now, boys, we've had enough fooling round—let's really get down to work". One can even visualise Katchen squaring his shoulders a bit before shaping up to his piano.

PROMINENT PIANO

In both records I thought the piano was too prominent, although it is essential that it must be clearly heard at all time. As it is the orchestral colors are rather pale, and the piano natters away on occasions with very little support. In this respect the Rachmaninoff is the best side, and there are times, notably near the end, where the balance and sound in general is quite impressive.

There will be better recordings of both works before we are done, but there is enough good work on this disc to make it worth hearing. The fact that it plays best on an NAB setting is perhaps the best comment on the general balance, but by so doing you will quieten the edge on the strings and provide a strength in the bottom and middle range with considerable improvement. The surface is average, but not dead quiet. The best thing in it—the playing of Katchen.

HOLST—The Planets Opus 32 played by the London Symphony Orchestra conducted by Sir Malcolm Sargent. Decca LXTA 2871.

Only recently Nixa came out with a particularly fine recording of the "Planets" so that this new one some very solid competition. is bad luck for Sargent, bec his efforts are too good to risk b overshadowed by another.

But, except for the actual rec ing, there isn't a great deal tween them. Say what you there is a melodrama about music which will weigh heavily the purchaser's mind, and with exhilarating Mars of the Nixa ter ing to show off what his equipm can do, we mustn't blame him he favors it rather than the De

FORWARDNESS

The Nixa superiority is among other things to the gre forwardness of the recording wh has been achieved without los breadth and weight. There is more drama in that Mars t there is on the Decca, but th is a great deal more impact.

The quality of the timpani is good example. Boult's orches concludes that movement with a v tual explosion on the drumh which on wide range equipm has startling realism which more than a little to do with wider frequency range of the d

But I must conclude on the sa note as I began—this really is very fine recording, and it is qu conceivable that you will find less violent approach easier to t —and to play.

The surface generally is smooth than the Nixa, the orchestra is m remote so that your mental seat sition is farther down the hall. think we are lucky in having such good records to choose fro

OUR BLOOD IS WONDERFUL FLUID

(Continued from Page 19)

from mumps will greatly reduce the severity of the attack.

A feature of the fractional processing of blood is that all the products have a very remarkable stability and purity. It has been found that they can be kept for periods far exceeding that of any other products and have no precedent in the chemistry of proteins.

Gamma globulin has been kept for 11 years without refrigeration. Albumin has lasted for over five years, and other proteins seem to be indefinitely stable.

Thus, once again, science has been able to further the well-being of mankind and helped to make his lot on earth a little more hopeful. It's funny, isn't it? On the one hand scientists are doing their best to save man while others are inventing the means to destroy him. Can't work this out. Can you? Ta-ta for now!

GAS FIGHTS FOG

Traffic in Los Angeles, Calif., extremely dense, and the city h been troubled by heavy fogs, whi slow traffic to almost a snail's pa

Laboratory tests established th unburnt motor fuel particles flo ing in the atmosphere contribut to the occurrence of fog by ser ing as seeds around which atmo pheric water could condense.

Present-day motor fuels have molecular weight of 150 to 200, a cannot be perfectly burned in co ventional car engines. They th contribute to the fog.

Liquid gases, such as propane butane, have a much lower mol cular weight, of the order of to 60. They also burn complete to carbon dioxide and water wit out any microscopic solid residue

Dr. Robertson, of the Californ State University, who carried o the necessary research, suggeste that if motorists used such lig fuels, the fog menace around L Angeles may be alleviated.

Car engines do not need majo modifications for the new fuel, b refineries would have to be adapte for its production.

FROM THE SERVICEMAN WHO TELLS

(Continued from Page 45)

MOVE THE PLUG

appeared most likely that the
i had failed just near the ap-
nce plug and it spluttered in-
nittently as the iron was moved.
Pa simply turned off the switch
, without bothering to remove
cord from the power socket,
ceeded to pull the appliance cord
of the iron and dismantle it.
few moments later he received
asty shock and was staring, very
zled, and badly shaken, at the
e appliance contacts, which he had
nly believed were quite dead.
ubsequent investigation by my
nd revealed the following points:
the switches on the outlet board
re in the neutral line, purely
reason of the manner in which
main power point was wired
i which is by no means stand-
lised. (2) The faulty lead in the
pliance cord also happened to be
nected to the neutral line. (3)
was standing on a concrete floor.
Apparently it was just pure good luck that Pa's shoes were sufficiently dry to limit the current flow to less than a dangerous value, but, fortunately, sufficiently conductive to give him a warning shock. Had it not been for this latter point he might well have failed to realise the danger of the situation until he touched a more effective earth—with, possibly, fatal results.

As it was it merely served as a very effective lesson on the inadvisability of trusting switches.

In case the above should sound like an indictment of the home-made multiple outlet board, let me assure you that I have found plenty of regular power points in which the same hazard exists. Just how they came to be like that I have no means of knowing, but I feel bound to say that some, at least, could only have been that way from the time of their installation, and that they had clearly been installed by a professional electrician.

So the home mechanic is not always to blame. He should, however, be careful.

HERE'S YOUR ANSWER TOM!

(Continued from page 59)

ckle another one of Tom's ques-
ons. This one is not concerned
ith the earth we stand on, nor
ith things on the ceiling above
; but with the transmitter three
iles away, which is causing some
ther in Tom's amplifier.

I have a small amplifier which can pick up the local broadcasting stations. The transmitter is three miles away. How can you explain this? How can you receive a signal without a detector or tuned circuits?

We agree, Tom, that there are
o tuned circuits in the average
mplifier. But we don't agree that
here is no detector in it.

You see, almost any valve can
ct as a detector, even when they
re not supposed to do so. This
s due to the fact, that so far no
alves with a perfectly linear char-
cteristic curve have been made.

By "linear" we mean that the
utput from the valve is an exact,
lthough amplified, replica of the
nput.

The positive peak from the valve
utput charges this capacitor. The
negative peak, however, being
ompletely neutralise this charge. We
are so left with a small positive
harge. During the subsequent
ycles the same thing is repeated,
he charge only changing with the
nodulation of the signal.

In other words, the valve is act-
ing like the detector in an ordin-
ary receiver. Needless to say, the
variation of the charge due to modu-
lation is amplified in the following
valves in the normal manner, and
finally appears in the loudspeaker.

Its strength depends on a number of factors. First, the signal strength, which would be fairly high in the vicinity of the transmitter. The distortion in the first valve is also a controlling factor. The higher the distortion the higher the detected signal.

Further, if the amplifier is not earthed, the signal can arrive through the mains transformer. This also serves to illustrate a point we made earlier on these pages about earthing.

A combination of these circumstances allows an amplifier to function quite efficiently as a receiver.

If there is more than one radio station in the vicinity, their programs will come through at the same time, as there are no tuned circuits in the amplifier to separate them.

The remedy is fairly obvious. One must stop the RF signals from getting inside the amplifier. In some cases earthing the chassis will bring relief, because it would allow the shield between the primary and secondary of the mains transformer to function correctly. Most of the interfering signal arrives via the mains.

The wiring should be checked to see if there are long unshielded grid leads, which could pick up the signal. These should be shielded or tucked away into the corner of the chassis, as far away from the mains flex as possible.

If this does not bring the desired result, it may be necessary to enclose the amplifier in an earthed metal box, and fit suppressors in the mains lead just where it enters the box.

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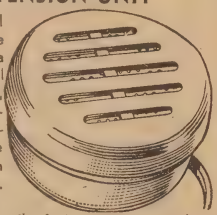

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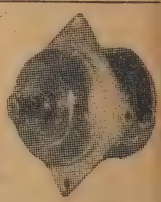

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6SN7	10/6	9004	7/6
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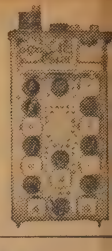

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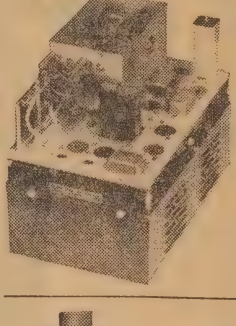

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640 KING STREET, ST. PETERS,
N.S.W.
PHONE LA6087

ANSWERS TO CORRESPONDENTS

..H.F. (Charters Towers, Nth. Qld.) sends in some information as the result of a query in the January issue of R. and H. from R.S., of Burwood, Vic., on the De Forest DV5 triode valve.

A. Many thanks for the information, H.F. We have forwarded same to R.S.

R.B. (Ivanhoe, Melbourne, Vic.) writes to us, sending in postal notes for two covers. He would like to construct the Playmaster No. 5.

A. We are glad to hear that the suggested remedies for your turntable have been effective and hope that you will have much pleasure playing your records on it. It certainly makes a difference if the reproduction of records is not marred by mechanical defects of the turntable.

D.H. (Randwick, NSW) writes that he obtained a lot of useful hints from our series of articles, Work Out Your Own Maths Problems and inquiries if we intend to reprint these.

A: We are glad that our articles were of so much use to you, D.H., but at the moment we have no plans for a reprint of these articles. If the circumstances warrant it, we may include them in some form of handbook.

K.R.M. (Prospect, SA) writes to congratulate R. & H. on its high standard and sends us some inquiries about the classes of operation of valves and the R. & H. Xtal Pickup Preamplifier.

A: We are glad that you like our magazine, K.R.M., and hope that it will provide you with some help in getting your "Ham Ticket". We assume that you are familiar with the actual operation of a radio valve and base our explanation on that assumption. The class of operation refers to the period of each input cycle during which plate current flows through the valve. In Class A operation, plate current flows during the full 360 degrees of each input cycle. In Class B operation plate current flows only during 180 degrees, and in Class C operation for less than 180 degrees. Class AB would therefore be a condition of operation under which the plate current would flow for considerably more than 180 degrees of the input signal.

The suffixes 2 and 1 indicate whether the grid is driven positive during the positive half cycle of the input signal or not. The class of operation is determined by the valve characteristics and the bias voltage applied to the control grid. Thus a valve would be operating under Class AB2 conditions if the input signal exceeded the negative grid bias during part of the positive half cycle, making the grid positive, but cutting the plate current completely off during part of the negative half cycle. Regarding the Xtal Pickup Preamp. The .1 meg resistor is provided for LP records and the .05 meg resistor for standard records. Due to limitations set by the average radio receiver the difference between the two positions of the switch would not be very great.

G.F. (Botany, NSW) expresses his satisfaction with the Radio & Hobbies Porta-Player and inquires if it is normal for the tone control to be very noisy.

A: It appears that the .05 mfd condenser between the plate of the 6BV7 and the tone control has become leaky or short-circuited. The result is that a DC of high voltage is flowing through the potentiometer making it run hot and noisy. We suggest, therefore, to try a new .05 capacitor of 600V rating in the tone control circuit.

The latest types of miniature valves do operate at a much higher temperature than older types so there is nothing to worry about in that direction.

C.S.F. (Marshall Free Bay via Geelong, Vic.) Would like to know what EMI, NAB, &c., settings mean.

A. You have rightly guessed that these letters have something to do with the tonal balance of records. It would be an easy matter to make records, if all frequencies from the lowest bass to the highest treble could be recorded at the same level. This is impossible, however, due to mechanics of the recording equipment and the qualities of the recording medium. In order to overcome these difficulties the bass has to be cut to allow the notes to be recorded within a certain maximum groove width. Treble on the other hand has to be emphasised to make it audible over the surface noise. This is indicated by a curve, showing the amount of cutting below and the boosting above a standard reference level. If each record be treated on its own merits, there would be an endless numb curves, resulting in hopeless confu and making exact reproduction in sible. Manufacturers therefore cut records according to certain stand These are referred to as EMI, NAB, and similar abbreviations. They e the listener to apply the appropriate boost and treble cut, thus bringin frequencies to the same level. Ther differences between the curves suffi to be detected on high fidelity e ment.

D.B.W. (Bendigo, Vic.) would lik know where he could obtain a re made chassis for the GP Junior Amp and what the price and freight ch would be.

A. We are not in a position to di the availability of parts, or their p Your best plan would be to contact of our advertisers specialising in RT kit sets. They should be able to a you re freight charges.

C.L.J. (Camberwell, Vic.) has built 3 Band S/W Receiver of August, but is disappointed with the results tained. He is using an electro dyn speaker in place of the normal pe type.

A. If you have simply connected speaker field in series with the choke without providing the co voltage power transformer there w be a very serious voltage drop ac the field and the performance of the would suffer severely. We suggest you change the set back to its orig form and try it with a permag spe or the existing speaker energised f some other source. Incidentally C. we prefer readers to give their full na even though we do not normally pub it.

G.A.B. (Tolga, Q) writes to tell u an unusual experience with his radio ceiver and home lighting plant, the c plaint being that the radio could no turned off by means of the regular swi The final solution to the problem is q interesting.

A. Many thanks for the story, G., and we will pass it on to the Serv man. In the meantime it would app that the switch connections could st some investigations, since it seems fa obvious that the circuit was being bro in the earthed lead rather than the act Had the active side been broken origin the problem would never have occur

D.G. (Kangaroo Pt., Bendigo, V prompted by "a reader's definition "Hi-Fi", sends in some definitions technical terms.

A. Thank you very much, D.G., your letter which we have filed for p sible reference.

S.S. (Parramatta, NSW) writes to th us for some recent information and tell us of some of his recent experime

A. Glad to learn that the informat was of some use to you, S.S., and t you appear to have solved most of y immediate radio problems. Here's hop that you get your one valve sets ope ting again soon.

No name (MacMahons Pt., NSW). fortunately all our efforts to decipher signature have been in vain and we only hope the writer will recognise answer from the address and text. Wh on the subject we suggest that all c respondents print their name and addr clearly. Many are quite meaningless normally written. The letter conta some valuable suggestions regarding construction of a tuner in a similar box to that used for the Playmaster C trol units. He also suggests a small b side set with switched tuning.

A. Many thanks for the suggestions a we will keep the ideas in mind. With a lot of checking we could not whether a satisfactory tuner could go the case but we will take the opportun to check the point.

The Radio, Television and Hobbies Query Service

All queries concerning our designs, to which a POSTAL REPLY is required must be accompanied by a postal note or stamps to the value of TWO SHILLINGS.

For the same fee, we will give advice by mail on radio matters, provided the information can be drawn from general knowledge. UNDER NO CIRCUMSTANCES, however, can we undertake to answer problems involving special research, modification to commercial equipment or the preparation of special circuits.

Whatever the subject matter, we must work on the principle that a letter is too involved if the reply takes more than 10 minutes of our time.

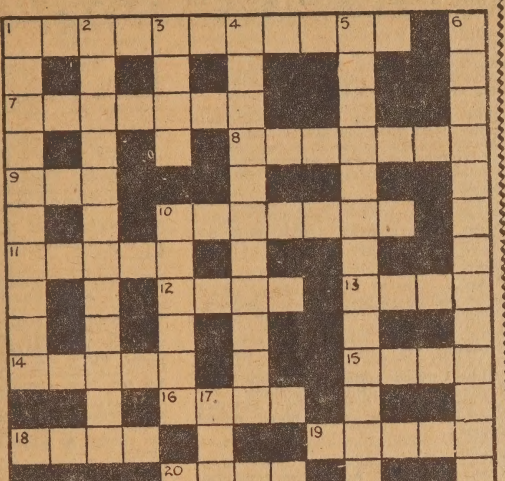
Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cutouts in standard chassis can be supplied for 5/-. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, RADIO, TELEVISION and HOBBIES, Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

HE R. & H. CROSSWORD No. 13



ACROSS

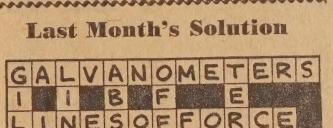
1. Semi-conductive devices.
7. Measures current.
8. Public transport vehicle.
9. Distress signal.
10. Simple type motor (two words).
11. "Medium" for electromagnetic waves.
12. Measure of length.
13. Part of a transformer.
14. Positive photographic transparency.
15. Trial.
16. Connected.
17. Morse code symbol.
18. Moving part of a motor.
20. One part of.

DOWN

1. Abrupt signal voltages.
2. Static.
3. Radio receiver (pl.)
4. Device for checking moving parts.
5. Radar—early English term (two words).
6. Television testing device (pl.).
10. Popular Xtal oscillator circuit.
17. Charged atom.

Solution and further crossword next month

Last Month's Solution



T.W. (Bathurst, NSW) writes to ex- ss his interest and appreciation of the gazine and to suggest a set along the s of the Porta-Player but incorpora- a tuner.

. Many thanks for your kind remarks suggestion, G.T.W., and we will keep ir idea in mind. Off hand we would like to say whether everything could accommodated in the same size e and still give a logical layout, but may try it when we get an opportun-

.F. (Ballina, NSW) being an air force io operator, inquires as to whether would be necessary to pass an exam ore obtaining a licence for operating amateur radio station.

. Before anyone can hold a licence for amateur radio station it is required t they satisfy the Post Master General's ice of their proficiency and fulfil the nditions set out by them. As far as know the only way to do this is to for the exams set by the PMG. How- er, we suggest that you contact the MG in Sydney and inquire as to the ocedure necessary in your case. Ad- ess your letter to the Radio Inspector, ireless Branch, PMG, Sydney.

R.A.I. (Rugly, NSW) submits a circuit a simple valve tester for checking the niature 1.5 volt filament valves.

A. Many thanks for your letter, R.A.I. e are filing your circuit with a possible ew to including it on the Reader Built page in a future issue of the magazine.

S.M.R. (Victoria) writes in appreciation the magazine and in particular of the ew Minivox (November 1952). He ex- ains that it is his first attempt at an C set and that it has given remarkably od results for such a small unit. In dition to the Melbourne stations, which e easily heard in daylight, he can re- ive many NSW stations at night, plus me Newcastle and country stations.

A. Many thanks for your kind remarks out the magazine, S.M.R., and we are ad to hear that you have had such good sults from this set. It is indeed quite markable what can be done with such mple circuits, provided one is prepared to build and adjust them carefully, as well as learn to tune them correctly. In the case of station interference it may be worth while reducing the aerial length a little but it is likely that you are trying to separate stations well spaced geographically but very close in frequency. In fact it is quite possible that some may be on the same frequency and are not intended to have a wide coverage.

R.K.S. (Bylong, NSW) is having trouble with the Vibra 5 and suspects that the grid resistors are of the wrong value.

A. Since the set has been aligned by a competent serviceman it should have been possible for him to tell you at the time that the sensitivity was poor and in what stage this condition existed. If he is unable to do this with the set in front of him, it is rather hopeless for us to offer much help at his distance. However, the set uses a perfectly straightforward circuit without any tricks and there is no reason why it should not perform correctly if correctly built. We can only assume that there is a faulty component in the set, in spite of the fact that they are all new. We think you are a little off the track regarding the grid resistors, though we are not quite sure to which ones you are referring. However, they are not as critical as you seem to imply and the normal 10 pc or even 20 pc tolerance would be satisfactory. In any case, reducing a bias resistor would be more likely to increase the current drain rather than reduce it. If you could let us have further details of the exact resistors involved and the values which you suggest we would be in a better position to advise you. Many thanks for your kind remarks about the magazine and staff. We hope you will continue to find it interesting and informative.

A.H. Dunedin (N.Z.) has just built himself a small amplifier which is working very well except for one puzzling feature. This is the ability of the unit to pick up signals from a broadcast station about three miles away. As A. H. points out, there appears to be no tuned circuit or detector in such a device and he wants to know how this reception is possible.

A.: Yours is not an unusual experience A.H. and we could relate many stories, many of them quite amusing, of similar experiences. You are quite right in saying that there is no tuned circuit but this is hardly necessary. The station you are receiving is so close that its signals will be many times stronger than any other and so it would be the only audible. The detector is another matter. While we endeavor to eporate amplifying valves on the so-called "straight" portion of the characteristic curve it must be realised that this characteristic is only relatively straight and that some distortion is inevitable in any amplifier. Thus it is quite possible that any RF signal which is strong enough will be detected sufficiently to produce weak audio signals. It is also possible that the incoming signal could be strong enough to drive the valve into the non-linear portion of its characteristic, particularly if the bias was other than optimum. However this is not as likely as the first explanation. Many thanks for your kind remarks about the magazine and we trust it will continue to hold your interest.

YOUR FIRST TRANSISTOR

(Continued from Page 83)

extremely strong signals.

Typical values are 1000 ohms and at least .001 mfd as a bypass.

The Collector is fed through the phones from a "high-tension" battery. We used a normal 9-volt C-bias battery, from which the current drain is very small — something like 60 or 70 microamps, using the OC70 junction type transistor.

Note that the positive side of the battery must be earthed when using a P-N-P transistor in the circuit specified. If the battery connections are reversed, the Collector circuit conducts heavily of its own accord — being then "forward biased" — and the transistor may suffer permanent damage as a result.

In point of fact, it isn't a bad idea to get the set going with a low collector voltage applied, then step it up later to 9 volts. Actually, there is surprisingly little difference in performance with such a large variation in voltage.

At a later stage, when we start applying higher voltages to transistors, we will discover that they have to be protected against overload of this nature and a close watch kept on electrode dissipation.

But we've said enough for one month. We suggest you start right in to building your first transistor receiver.

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WANTED: Adaptor. Can anyone su diagram and selector positions "Naval" and 7 pin valve adaptor "Radameta" Tester. Information wil paid for. **W. Higgins, 40 Auburn G East Hawthorn, Melbourne.**

WANTED: AR7 HRO or national dial urgently. **K. A. Chaplin, A Bay, Vic.**

WANTED: Urgently AR7 or HRO dial. **K. A. Chaplin, Apollo Bay,**

WANTED: 2 control boxes and ca also handbook for A.R.B. airc receiver. **R. Campbell, Box 42, P.O., rento, Vic.**

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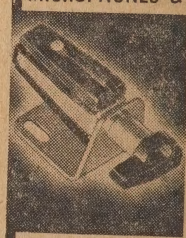

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